Dietary and Lifestyle Practices of People Who Use Drugs

Dietary and Lifestyle Practices of People Who Use Drugs Undergoing Treatment for Recovery in Lebanon

DISSERTATION
to obtain the degree of Doctor at the Maastricht University,
on the authority of the Rector Magnificus,
Prof. dr. Pamela Habibovic
in accordance with the decision of the Board of Deans,
to be defended in public on
Wednesday, 21st of December 2022 at 10:00 hrs.

By
Nadine Mohamad Samih Mahboub

Supervisor:

Prof. Dr. Nanne de Vries, Maastricht University, Maastricht, Netherlands

Co-supervisor:

Dr. Rana Rizk, Lebanese American University, Byblos-Lebanon/ Institut National de Santé Publique, d'Epidémiologie Clinique, et de Toxicologie (INSPECT-LB), Beirut- Lebanon.

Assessment Committee:

Prof. dr. S.P.J. Kremers (Maastricht University) / (Chair);
Prof. dr. R.M.M. Crutzen (Maastricht University);
Dr. M. Spigt (Maastricht University);
Prof. dr. P. Salameh, Lebanese University, Beirut, Lebanon;
Prof. dr. H. Tamim, American University of Beirut, Beirut, Lebanon.

Funding

This work was supported by the Institut National de Santé Publique, d'Epidémiologie Clinique, et de Toxicologie (INSPECT-LB), Beirut- Lebanon.

Content

Chapter 1

General Introduction

The Republic of Lebanon, commonly known as Lebanon, is a small country located in the Near-East where three continents meet: Europe, Asia, and Africa. Until 1975, even though Lebanon was a drug-producing country, usage was low (MOPH, 2016). During the civil war spanning over 15 years (1975-1990), Lebanon showed a rapid progression of substance use disorder (SUD). From the onset of war, drug use was a common phenomenon among the militias and soon progressed to the civilian population due to the easy access of drugs, socioeconomic crises, and the fragility of the population after the armed conflicts (MOPH, 2016). Since the civil war, the influx of Palestinian and Syrian refugees created new security and health challenges in the country (MENHARA, 2018); drug trafficking and use spread in refugee camps, exacerbating the drug use scene in Lebanon (MENHARA, 2018; MOPH, 2016). All of these factors warrant the growing demand on SUD detection and treatment in the country. Research on SUD in Lebanon is scarce and when present, it either focuses on the prevalence of a specific drug in a specific segment of the population (Karam et al., 2010), or on the prevalence of infectious diseases among people who inject drugs (PWID) for harm reduction policy adoption (MENHARA, 2021). Most of these studies are done qualitatively and are limited to small sample sizes. Studies focusing on their nutritional status, dietary and lifestyle practices of people who actively use drugs (PWUD) and those who are undergoing treatment for recovery are non-existing.

This dissertation aims to explore the dietary and lifestyle practices of PWUD undergoing treatment for recovery in Lebanon. We open this chapter with a description of the global drug use epidemiology, followed by information on the Middle East and North Africa region (MENA) region then specifically Lebanon. We present next the health consequences of SUD and the different treatment modalities in this regard. Furthermore, we display the current knowledge on the nutritional and lifestyle practices of PWUD and during treatment. Finally, we highlight the importance of a multifactorial public health intervention in treatment centers addressing the nutritional and lifestyle practices with therapeutic and relapse-prevention implications. We conclude with the objectives and outline of the dissertation.

Definition of Substance Use Disorder and epidemiology

SUD is a chronic relapsing disorder characterized by physiological, behavioral, and cognitive phenomena leading to craving and a strong overwhelming desire or need for the substance (American Psychiatric Association, 2013; WHO, 1993). The Diagnostic and Statistical Manual of Mental Disorders (DSM-V) defines the following criteria for diagnosing SUD: 1) clinical representation of tolerance and withdrawal, 2) ingestion of large amounts of drugs, 3) repeated attempts and failure of cessation, 4) spending considerable time on obtaining the substance, 5) discontinuing social and daily tasks due to the abuse, and 6) failure to stop the act even though severe physical or psychological problems might have risen (Hasin et al., 2013). Illicit drugs that are consumed on a regular basis and can lead to SUD include cannabis, hallucinogens, opioids, sedatives, hypnotics, anxiolytics, cocaine, heroin, and amphetamines and its derivatives (American Psychiatric Association, 2013; WHO, 1988). Furthermore, the unsupervised pharmaceutical use of these illicit drugs remains a concern and can lead to SUD and even death (Nabipour et al., 2014). More than a quarter of a billion people, nearly 5.5% of the global population, aged 15 to 64 years are estimated to use illicit drugs at least once daily, and 35 million, around 0.71% of the world population, suffer from severe SUD (UNODC, 2019). The prevalence, patterns, and severity of substance use have changed over the years and differ across countries. To date, opioids are the most harmful type of used drugs as they are associated with fatal and infectious diseases. Globally, around 62 million people, 1.2% of the adult population use opioids for non-medical purposes, with the highest prevalence being in North America and lowest in Europe (UNODC, 2020). Cannabis remains the world's most widely used drug, with a prevalence of 4% of the adult population (UNODC, 2019). Its use has increased in parts of North and South America, while it is declining or stabilizing in parts of Europe. Amphetamines are the second most commonly used drug worldwide and are perceived to be increasing in many sub-regions including North America, most parts of Asia, western and central Europe, and in the Middle East (UNODC, 2019).

The MENA region is considered an arena for the manufacture, export, and use of drugs. It is composed of 20 countries extending from Pakistan to Morocco including Lebanon. The most commonly used drugs in the region include heroin (Egypt and Morocco), cannabis (mostly in Lebanon, followed by Tunisia and Morocco) and cocaine (especially in Morocco and Lebanon).

Prescription drugs were used by 22.7% of people who use drugs in the region and the number of PWID was estimated to be around 887,000 (MENHARA, 2018).

Lebanon, a part of the MENA region, has various drugs that are currently available such as marijuana, hashish, heroin, cocaine, amphetamines, in addition to synthetic drugs like 3,4-methylenedioxymethamphetamine (MDMA) commonly known as ecstasy, and Captagon. All of these factors result in a wide availability and accessibility of illicit drugs leading to extensive use estimated to be higher than the global average (MOPH, 2016; UNODC, 2018). Due to the legislative framework, social discrimination, and the taboos surrounding drug users in Lebanon, most of them suffer from social exclusion and unemployment rendering them less accessible; this particularly holds true for females (MOPH, 2016). A quarter of the population is under 15 years of age and around 85% live in urban areas, concentrated in Beirut and Mount Lebanon (MOPH, 2014). Increasing rates of use of addictive drugs, and alcohol, especially among youth are reported. About 4.7% of students in public and private schools, aged 13 to 15, reported using one or more drugs simultaneously, and more than 70% of them reported using drugs before the age of 14 (MOPH, 2017). Cannabis is the most commonly used drug among high school and university students, nevertheless, heroin (31%), followed by cocaine (20%), and cannabis (17%) were the most commonly used drugs among those seeking treatment (MENHARA, 2018).

Trends in drug use are influenced by several factors related to the individual, family, community, and the environment. To project the future global extent of drug use, the size and composition of the population are to be considered (UNODC, 2020). As a reflection of the population growth, an estimated 11% increase in people with SUD is expected by 2030. This is the target year for achieving the Sustainable Development Goal: Good Health And Well-Being, targeting the prevention and treatment of SUD (UNODC, 2021). The strongest growth in population and thus in the projected number of people with SUD, will take place in lower income countries. More developed regions, in particular Europe, will likely see a decline in the number of people with SUD by 2030 (UNODC, 2021). Furthermore, adolescence and young adulthood is a critical risk period for initiating drug use. Low-income countries have a younger population that is expected to increase over the next decade, thus increasing the prevalence of drug use among these countries (UNODC, 2019).

Another factor that could contribute to the increase in drug use in some regions is the closing of the gap between men and women in terms of drug use. This might lead to a higher total number of drug users than that projected on the basis of population growth (UNODC, 2021). Finally, changes in levels of drug use are likely to occur as a result of changes in drug legislation and in its implementation, changes in youth culture, risk perceptions, social norms and urbanization (UNODC, 2020).

A concerning rise in synthetic cannabinoid and pharmaceutical drugs in a number of countries in the MENA region has been noticed and documented in regional assessment reports (MENHARA, 2021). Data are relatively limited and mainly describe trends of drug use in the previous and current years with no future projections. As for Lebanon, reports on drug prevalence were conducted by NGOs and some academics on specific population groups with limited contributions from the Lebanese authorities (MOPH, 2014).

Health consequences of substance use disorder

SUD has a detrimental impact on health and substantially contributes to the global burden of communicable and non-communicable diseases. It is linked to HIV and Hepatitis, in addition to increased risk of long-term health complications like cardiovascular, liver, pulmonary diseases (Spronk et al., 2013; Volkow et al., 2013), and other psychological disorders (Degenhardt & Hall, 2012). Globally, an estimated 13 million PWID are living with human immunodeficiency virus (HIV) (MENHARA, 2021) and around 271,000 of the deaths attributable to the use of drugs were the result of liver diseases resulting from hepatitis C (UNODC, 2021).

Furthermore, socio-economic disadvantage, low educational attainment, unemployment, and financial instability are interrelated with SUD and have implications on society (UNODC, 2020). SUD imposes costs upon the individual drug user, families, community, and society as a whole. Studies examining the costs associated with SUD treatment are still few. The benefits of treatment in the United States substantially outweigh the costs of investment in drug treatment (Flynn, 2002). Moreover, drug use costs the United Kingdom National Health Services (NHS) around 500 million pounds yearly. For every 1pound spent on drug treatment an estimated 2.5 pounds are saved on costs for health and criminal justice (NHS National Treatment Agency for Substance Misuse, 2016). Successful treatment is important as it saves money and benefits the society by the recovery of these individuals.

The MENA region, like other regions in the world, faces several health challenges associated with SUD mainly pertaining to psychiatry and mental health (Hankir & Sadiq, 2013; Jaalouk et al., 2012). The scarcity of research might suggest a lack of good mental health services and rehabilitation centers for treatment (Okasha et al., 2012). SUD is considered a serious public health risk in Saudi Arabia associated with many psychiatric disorders, medical diseases and educational, occupational, legal, and social consequences (Bassiony, 2013). Furthermore, patients with substance dependence in Egypt had a significantly worse overall quality of life than the WHO standards that was evident in the physical, psychological, level of independence, social, and spiritual domains (Said et al., 2012).

Similarly, SUD is a rising public health concern in Lebanon. The significant influx of refugees in the past few years have stretched the country's capacity to respond to mental health, SUD, and related infectious diseases (WHO- EMRO, 2016). Evidence shows a high prevalence of substance use with increased burden of disease related to it (Karam et al., 2010; MOPH, 2014). 61.4% of patients with SUD in Lebanon have anxiety disorders that might be related to the political and financial difficulties the country faced as the result of the war (Haddad et al., 2020). Furthermore, 37.7% of heroin dependent patients had a personal history of suicidal attempts and 14.8 % had current suicidal ideas (Kazour et al., 2016). This population shares several risk factors of suicide such as impulsivity, depression, and underlying psychopathology representing a major burden to public health.

Treatment models of substance use disorder

Effective treatments for SUD are essential to reduce the impact of substance use on both the individual and society (Forray & Sofuoglu, 2014). Recurrent drug intoxication is modulated by genetic, developmental, and environmental factors and is a predictor for relapse and a target for treatment (Dematteis et al., 2017; Goldstein & Volkow, 2002). Although complete abstinence from illicit drugs is a desirable goal of treatment, a substantial reduction in the patient's consumption of illicit drugs and the ability to function in society is seen as an appropriate definition of recovery (Gerstein & Lewin, 1990). Further goals may focus on reducing street crime, developing educational or vocational capabilities, restoring employment, averting fetal exposure to drugs, and

improving general health, psychological functioning, and family life (Andersson et al., 2021; Gerstein & Lewin, 1990).

There are two main types of treatments used for SUD: detoxification (complete abstinence) or the opioid substitution treatment (OST) (Nabipour et al., 2014). Drug detoxification mostly takes place initially in hospitals, followed by 9-18 months of psychotherapy and behavioral modification in a therapeutic community or a rehabilitation center (Gerstein & Lewin, 1990). It is designed mainly for people with major behavioral and social impairments and it adheres to rigid designs (Guydish et al., 1999). The core features of the treatment include strict prohibitions against drugs and violent behaviors by enforcing close supervision. Given this, the attrition rates and early discharges are high (Vanderplasschen et al., 2013). By contrast, OST is an ambulatory medication-assisted program for opioid dependency. The patient receives a long-term opioid agonist (methadone or buprenorphine) to reduce the withdrawal symptoms and decrease the cravings for street opioids (Rapeli et al., 2007). The dosages given neither produce intoxication nor clinical behavioral impairment. Patients become more amenable to counseling and environmental changes, thus shifting their behaviors away from seeking drugs (Mattick et al., 2009). OST is suggested to be the most efficient in lowering blood-borne illnesses like infection with the human immunodeficiency virus (HIV) and hepatitis (Caplehorn & Ross, 1995).

In Lebanon, the main structured treatment programs offered are OST and rehabilitation services post detoxification. The Ministry of Public Health (MoPH) provides OST (Buprenorphine) in Lebanon since 2012 mainly through non-governmental organizations (NGOs). The main NGOs providing these services are: Skoun, Soins Infirmiers et Developpement Communautaire (SIDC), Association Justice Et Misericorde (AJEM), and Reset Clinics. Furthermore, the MoPH offers detoxification programs in two public hospitals, followed by rehabilitation in institutionalized centers either privately funded or governed and subsidized by the Ministry of Social Affairs. The main rehabilitation centers are: Oum El Nour, JAD (Youth Against Drugs), Jeunesse Contre la Drogue (JCD), Bonheur de Ciel, Nusroto Al Anachid, Cenacle de Lumiere, Al Hayka Al Soheyat Al Islamya, and Cedars. Treatment centers are centralized mainly in Mount Lebanon and Beirut areas. The care providers are social workers, psychologists, and psychiatrists offering evidence-based services such as social programs, cognitive behavior therapy, and pharmacotherapy. At one

center, patients receive Christo therapy which is a faith-based intervention focusing on prayers as means to overcome craving and addiction.

The number of patients suffering from drug use disorder seeking treatment in Lebanon ranges between 10,000-15,000, with 59% of them reportedly using heroin (MENHARA, 2018). SUD was partly linked with the presence of comorbid mental disorders like anxiety, depression, and bipolar disorders indicating the need for careful psychiatric assessment in the treatment of substance use (Karam et al., 2002).

Nutritional and lifestyle factors in substance use disorder and treatment

Nutrition is an important prerequisite for health; yet there is little nutritional guidance for people with SUD despite the fact that their food consumption is compromised risking malnutrition (Jeynes & Gibson, 2017). Several factors affecting the nutritional status of PWUD include: chaotic lifestyle leading to poor dietary quality and food insecurity (Tang et al., 2011), compromised liver storage of nutrients (Hossain et al., 2007), decreased appetite (Nazrul Islam et al., 2001) and altered metabolism (Tang et al., 2011). The literature assessing the nutritional status of PWUD points mostly towards malnutrition (Jeynes & Gibson, 2017). Heroin and cocaine users show lower energy and protein intake than non-users (Forrester et al., 2004; Saeland et al., 2009), with the majority of vitamins and minerals below the recommended intakes (Saeland et al., 2009). This intake seems to decline further with higher intensity and duration of drug use (Saeland et al., 2009; Santolaria-Fernandez et al., 1995). Furthermore, hidden deficiencies might be revealed by measuring plasma micro- and macronutrients indicating that anthropometric measurements might not be the ideal way of assessment in this population group. Finally, most of the evidence shows an inverse correlation between drug use, body weight, and body mass index (BMI) (Li et al., 2016; Tang et al., 2011).

Other lifestyle practices that are also affected by SUD are sleep and physical activity. Sleep is negatively affected by drug use (Duterte et al., 2001; Mahfoud et al., 2009). Substance use can alter the homeostatic balance of neurotransmitters involved in the regulation of sleep-wake systems, resulting in sleep disturbances and circadian dysregulation (Conroy & Arnedt, 2014). Longer sleep latency and reduced total sleep time are frequently cited adverse effect of cocaine and other substances used (Schierenbeck et al., 2008). Furthermore, evidence on the involvement of PWUD in physical activity is still controversial. Some studies suggest active involvement in

structured physical activity programs to divert from drug use (Fischer et al., 2012; Powers et al., 1999), while others show low participation (Abrantes et al., 2011; Neale et al., 2012).

Once referred to treatment, whether detoxification or OST, a major shift in the nutritional status and lifestyle practices of PWUD occurs (Cowan & Devine, 2012). Patients report better appetite and more desire to eat resulting in significant weight gain (Montazerifar et al., 2012; Novick et al., 1993; Van Strien et al., 2009). This trend in weight gain may be attributed to the binge eating observed as a result of the replacement of drugs with food (Van Strien et al., 2009), changes in the eating behaviors of users after periods of food restriction caused by drugs (Cowan & Devine, 2012), compromised neurological mechanisms in the brain leading to food addiction (Lee et al., 2014; Meule & Gearhardt, 2014), pharmacological treatments received (Müller et al., 2004; Wetterling & Müssigbrodt, 1999), or due to the methadone itself (Mysels & Sullivan, 2010). In addition, studies have demonstrated addictive behaviors for foods high in sugars and fats among PWUD undergoing treatment (Lee et al., 2012; Lee et al., 2014; Meule & Gearhardt, 2014). The neurobiological pathways regarding expressions of dopaminergic and opioid systems have shown quite a similarity between individuals who were exposed to these energy dense foods and those exposed to drugs of abuse (Lerma-Cabrera et al., 2015).

Interestingly, the majority of the micronutrients remain below the recommended levels of intake which could be related to the increased intakes of energy-dense foods, rather than nutrient-dense ones (Kolarzyk et al., 2005; Varela et al., 1997). This issue remains understudied and the possibility of having hidden nutrient deficiencies in this population needs further investigations.

Studies regarding the effect of treatment on metabolic parameters are limited where the majority of these studies are on PWUD undergoing methadone maintenance treatment (MMT). After six months of MMT, increased serum total cholesterol, low-density lipoproteins (LDL), and triglyceride levels (TG) are seen among users as compared with pre-treatment levels (Housova et al., 2005; Montazerifar et al., 2012). This elevation could be attributed to heredity and lifestyle factors that need further investigations. On the other hand, serum high density lipoproteins (HDL) decrease significantly as compared with pre-treatment levels (Montazerifar et al., 2012). This decrease is associated with higher leptin levels seen leading to the down regulation of the hepatic clearance of HDL (Silver & jiang, 1999).

Looking at other lifestyle practices, prevalence of sleep disorders was mainly addressed in PWUD undergoing MMT. Inadequate sleep quantity and poor sleep quality were common among this population (Hsu et al., 2012; Peles et al., 2010; Zahari et al., 2016).

Sleep disturbances could be attributed to several factors like the duration and intensity of opiate abuse preceding treatment, alcohol and nicotine consumption, chronic pain and psychopathological problems present (Beswick et al., 2003). Attention to good sleep quality is warranted for proper treatment adherence and lower risk of relapse (Bertz et al., 2019). Furthermore, an association between weight gain and poor sleep has been demonstrated among healthy adults (Brook et al., 2013; Patel & Hu, 2008). Poor sleep and weight gain among this population group should be further investigated.

Physical activity is another important lifestyle factor that could be used as an adjunct therapy for PWUD as it is related to an increase of days of abstinence from drug and alcohol use (Brown et al., 2010). Furthermore, emerging evidence demonstrated the benefits of physical activity in decreasing anxiety, depression, withdrawal symptoms, in addition to improving self-confidence (Bardo & Compton, 2015; Roessler, 2010). Studies on physical activity as a component of drug abuse treatment are suggestive, however the recommendations on the type and duration of physical activity to inflict the benefits mentioned require further exploration.

Importance of a multifactorial intervention in treatment centers and use of intervention mapping

SUD is of a serious concern to society due to its negative effect on the development of communities (Karajibani et al., 2014). Treatments for SUD focus mainly on pharmacotherapy and psychotherapy in a strict disciplined routine as means to prevent relapse. Studies emphasizing proper nutrition, physical activity, and adequate sleep, that might be potentially associated with better physical and mental wellbeing in SUD, are scarce. This failure to address multiple risk behaviors neglects the opportunity in helping to reduce incidences of chronic diseases in this population (Cowan & Devine, 2012). Appropriate intervention strategies and public health programs to improve the nutritional status and lifestyle practices in SUD treatment centers need to be developed and tested based on extensive research among this population group. Healthy lifestyle challenges that PWUD in treatment centers face must be addressed to limit the rise of the noncommunicable diseases that may pose a serious public health burden in the future. Treatment

centers provide a safe and stable environment for PWUD, so integrating a multifactorial intervention program combining educational and environmental components and addressing the individuals' needs and preferences as part of the treatment modality in these centers must be further explored. Investigating the impact of incorporating interventions promoting proper nutrition, good-quality sleep, and physical activity paves a comprehensive approach to mental health treatment and decreased risk of relapse (Davidson et al., 2008; Hosker et al., 2019).

Rationale for using intervention mapping

The development of effective health promotion interventions often requires reviews of the relevant literature, behavioral change theories, collection of new data, and involvement of experts, community members, and stakeholders in the planning process (Fernandez et al., 2019). Intervention mapping (IM) is a planning framework that provides a systematic process and detailed protocol for effective, step-by-step decision-making for intervention development, implementation, and evaluation (Brug et al., 2005; Fernandez et al., 2019).

Steps followed in IM are: 1) understanding of the health problem of the population at risk, causes and its determinants 2) describing the behavioral and environmental outcomes, creating objectives for changes in the determinants of behavior and environmental causes, and specifying the targets of the intervention program, 3) identifying theory- and evidence-based behavior change methods that influence the determinants, 4) combining the intervention components into a coherent program, 5) developing implementation strategies and 6) planning both process and outcome evaluation to assess program efficacy (Bartholomew et al., 2006).

IM was chosen as the framework for the intervention program yet to be developed because it provides the most detailed guide on what to do. IM describes the path from problem identification to problem solving (Kok & Mesters, 2011).

Developing and implementing a health promotion intervention for treatment centers requires baseline data about dietary and lifestyle practices to identify the risks and address them. Little data on this vulnerable group are available worldwide and in Lebanon.

Accordingly, the aim of this research work is to explore dietary and lifestyle practices in a sample of PWUD undergoing treatment for recovery in Lebanon recruited from three OST and four rehabilitation centers located mainly in Beirut and Mount Lebanon areas, as shown in Figure 1.

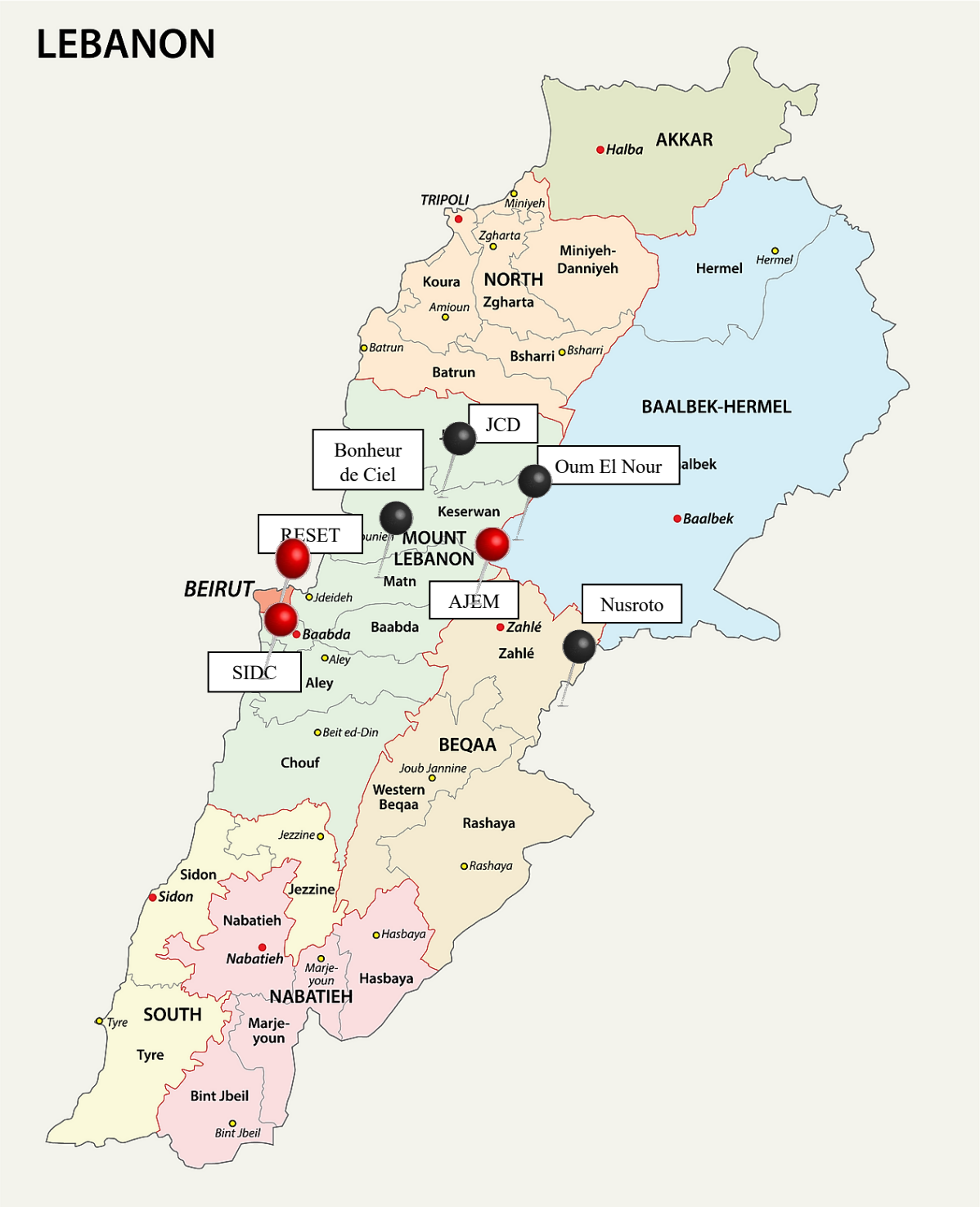

Figure 1: Locations of the treatment centers

Rehabilitation centers are pinned in black; Opioid substitution treatment centers are pinned in red. JCD: Jeunesse Contre la Drogue; SIDC: Soins Infirmiers et Developpement Communautaire; AJEM: Association Justice Et Misericorde

More specifically, in Chapter 2, we review the nutritional issues faced by PWUD or those undergoing treatment for recovery. Data on the effect of drug use on dietary intake and habits, anthropometric indices, body composition, nutrient deficiencies, and metabolic parameters are examined to provide better insights on the topic. In Chapter 3, we qualitatively explore dietary and lifestyle practices of PWUD undergoing treatment in rehabilitation centers in Lebanon and perceived benefits and pitfalls. In Chapter 4, and due to the scarcity of studies addressing nutritional and lifestyle practices of this population group globally and in Lebanon, we examine the nutritional parameters, dietary intake, nutrition knowledge, food addiction, and biochemical profiles, as well as different lifestyle practices, including sleep and physical activity, among PWUD undergoing treatment for recovery in Lebanon. In addition, we explore differences present among the two offered treatment modalities, namely OST and rehabilitation. In Chapter 5, being a risk factor for relapse and chronic diseases, we investigate the patterns and determinants of weight gain seen in PWUD undergoing treatment for recovery. In Chapter 6, we reflect on the major findings of the dissertation and discuss its methodological strengths and limitations, as well as its clinical, public health, and research implications. The ultimate goal of this thesis is to provide a better understanding of the above factors to pave the way for an evidence-based public health program specifically targeting this population group.

The objectives of this dissertation and its organization are summarized in Figure 2.

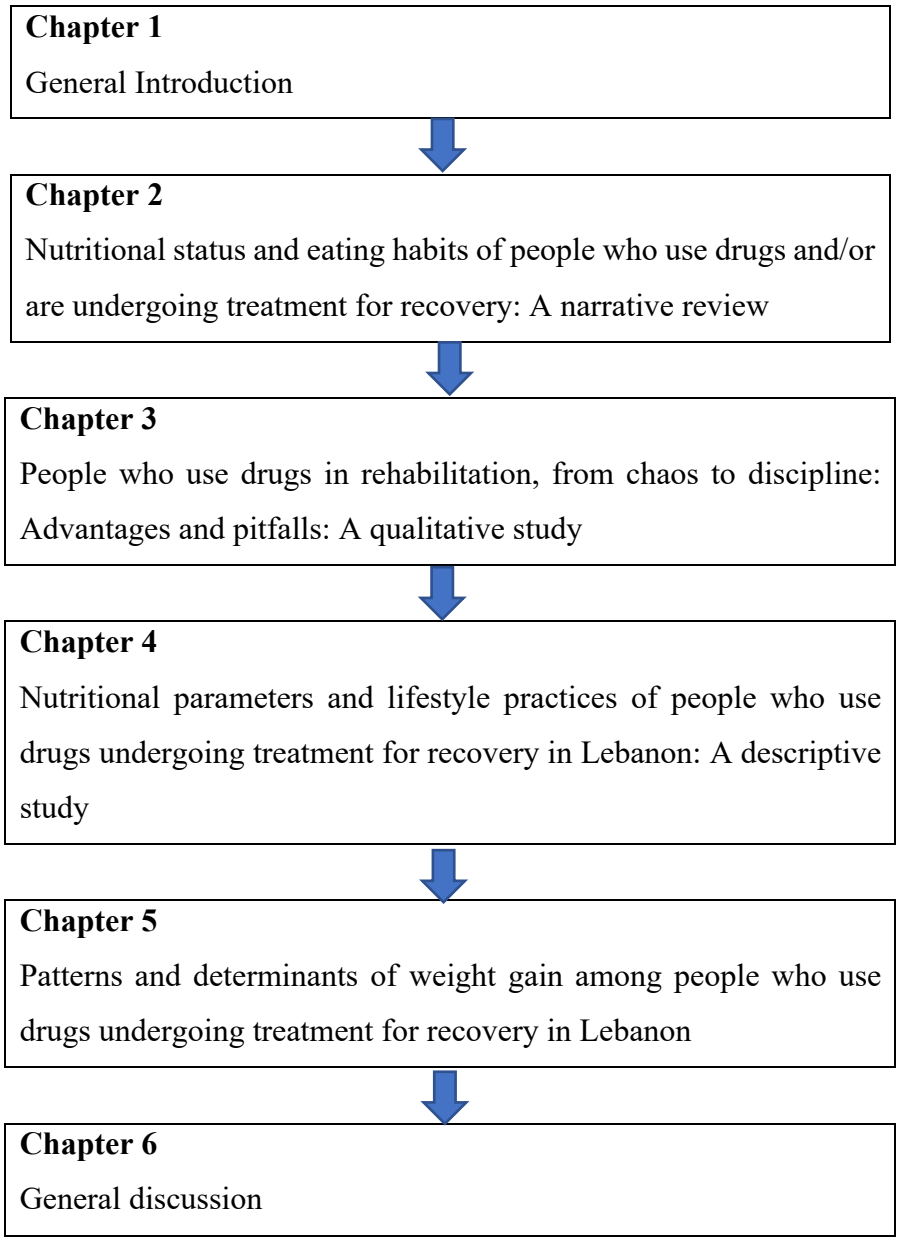

Figure 2: Outline of the dissertation

References

Abrantes, A. M., Battle, C. L., Strong, D. R., Ing, E., Dubreuil, M. E., Gordon, A., & Brown, R. A. (2011). EXERCISE PREFERENCES OF PATIENTS IN SUBSTANCE ABUSE TREATMENT. *Ment Health Phys Act*, *4*(2), 79-87. https://doi.org/10.1016/j.mhpa.2011.08.002

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5®)*. American Psychiatric Pub.

Andersson, H. W., Lilleeng, S. E., & Ose, S. O. (2021). Comparison of social and sociodemographic characteristics and treatment goals of persons with alcohol versus drug use disorders: Result from a national census of inpatients in specialized treatment for substance use. *Addictive Behaviors Reports*, *13*, 100340.

Bardo, M. T., & Compton, W. M. (2015). Does physical activity protect against drug abuse vulnerability? *Drug Alcohol Depend*, *153*, 3-13. https://doi.org/10.1016/j.drugalcdep.2015.05.037

Bartholomew, L. K., Parcel, G. S., Kok, G., & Gottlieb, N. H. (2006). *Planning health promotion programs: An intervention mapping approach, 2nd ed*. Jossey-Bass.

Bassiony, M. (2013). Substance use disorders in Saudi Arabia. *Journal of Substance Use*, *18*(6), 450-466.

Bertz, J. W., Epstein, D. H., Reamer, D., Kowalczyk, W. J., Phillips, K. A., Kennedy, A. P., . . . Preston, K. L. (2019). Sleep reductions associated with illicit opioid use and clinic-hour changes during opioid agonist treatment for opioid dependence: Measurement by electronic diary and actigraphy. *J Subst Abuse Treat*, *106*, 43-57. https://doi.org/10.1016/j.jsat.2019.08.011

Beswick, T., Best, D., Rees, S., Bearn, J., Gossop, M., & Strang, J. (2003). Major disruptions of sleep during treatment of the opiate withdrawal syndrome: differences between methadone and lofexidine detoxification treatments. *Addict Biol*, *8*(1), 49-57. https://doi.org/10.1080/1355621031000069882

Brook, J. S., Lee, J. Y., Finch, S. J., Balka, E. B., & Brook, D. W. (2013). Physical factors, personal characteristics, and substance use: associations with obesity. *Subst Abus*, *34*(3), 273-276. https://doi.org/10.1080/08897077.2013.770425

Brown, R. A., Abrantes, A. M., Read, J. P., Marcus, B. H., Jakicic, J., Strong, D. R., . . . Gordon, A. A. (2010). A pilot study of aerobic exercise as an adjunctive treatment for drug dependence. *Mental Health and Physical Activity*, *3*(1), 27-34. https://doi.org/https://doi.org/10.1016/j.mhpa.2010.03.001

Brug, J., Oenema, A., & Ferreira, I. (2005). Theory, evidence and Intervention Mapping to improve behavior nutrition and physical activity interventions. *Int J Behav Nutr Phys Act*, *2*(1), 2. https://doi.org/10.1186/1479-5868-2-2

Caplehorn, J. R., & Ross, M. W. (1995). Methadone maintenance and the likelihood of risky needle-sharing. *Int J Addict*, *30*(6), 685-698.

Conroy, D. A., & Arnedt, J. T. (2014). Sleep and substance use disorders: an update. *Curr Psychiatry Rep*, *16*(10), 487. https://doi.org/10.1007/s11920-014-0487-3

Cowan, J. A., & Devine, C. M. (2012). Process evaluation of an environmental and educational nutrition intervention in residential drug-treatment facilities. *Public Health Nutrition*, *15*(7), 1159-1167. https://doi.org/10.1017/S1368980012000572

Davidson, L., Andres-Hyman, R., Bedregal, L., Tondora, J., Frey, J., & Kirk, T. A. (2008). From "Double Trouble" to "Dual Recovery": Integrating Models of Recovery in Addiction and Mental Health. *Journal of Dual Diagnosis*, *4*(3), 273-290. https://doi.org/10.1080/15504260802072396

Degenhardt, L., & Hall, W. (2012). Extent of illicit drug use and dependence, and their contribution to the global burden of disease. *Lancet*, *379*(9810), 55-70. https://doi.org/10.1016/s0140-6736(11)61138-0

Dematteis, M., Auriacombe, M., D'Agnone, O., Somaini, L., Szerman, N., Littlewood, R., . . . Soyka, M. (2017). Recommendations for buprenorphine and methadone therapy in opioid use disorder: a European consensus. *Expert Opin Pharmacother*, *18*(18), 1987-1999. https://doi.org/10.1080/14656566.2017.1409722

Duterte, M., O'Neil, S., McKearin, G., Sales, P., Murphy, T., & Murphy, S. (2001). Walking the tightrope: balancing health and drug use. *J Psychoactive Drugs*, *33*(2), 173-183. https://doi.org/10.1080/02791072.2001.10400482

Fernandez, M. E., Ruiter, R. A. C., Markham, C. M., & Kok, G. (2019). Intervention Mapping: Theory- and Evidence-Based Health Promotion Program Planning: Perspective and Examples. *Front Public Health*, *7*, 209. https://doi.org/10.3389/fpubh.2019.00209

Fischer, J., Butt, C., Dawes, H., Foster, C., Neale, J., Plugge, E., . . . Wright, N. (2012). Fitness levels and physical activity among class A drug users entering prison. *Br J Sports Med*, *46*(16), 1142-1144. https://doi.org/10.1136/bjsports-2011-090724

Flynn, R. (2002). Clinical governance and governmentality. *Health, Risk & Society*, *4*(2), 155-173. https://doi.org/10.1080/13698570220137042

Forray, A., & Sofuoglu, M. (2014). Future pharmacological treatments for substance use disorders. *British Journal of Clinical Pharmacology*, *77*(2), 382-400.

Forrester, J. E., Tucker, K. L., & Gorbach, S. L. (2004). Dietary intake and body mass index in HIV-positive and HIV-negative drug abusers of Hispanic ethnicity. *Public Health Nutr*, *7*(7), 863-870.

Gerstein, D. R., & Lewin, L. S. (1990). Treating drug problems. *New England Journal of Medicine*, *323*(12), 844-848.

Goldstein, R. Z., & Volkow, N. D. (2002). Drug addiction and its underlying neurobiological basis: neuroimaging evidence for the involvement of the frontal cortex. *American Journal of Psychiatry*, *159*(10), 1642-1652.

Guydish, J., Sorensen, J. L., Chan, M., Werdegar, D., Bostrom, A., & Acampora, A. (1999). A randomized trial comparing day and residential drug abuse treatment: 18-month outcomes. *J Consult Clin Psychol*, *67*(3), 428-434. https://doi.org/10.1037//0022-006x.67.3.428

Haddad, C., Darwich, M. J., Obeid, S., Sacre, H., Zakhour, M., Kazour, F., . . . Tahan, F. E. (2020). Factors associated with anxiety disorders among patients with substance use disorders in Lebanon: Results of a cross-sectional study. *Perspect Psychiatr Care*, *56*(4), 745-752. https://doi.org/10.1111/ppc.12462

Hankir, A., & Sadiq, A. (2013). Lessons from psychiatry in the Arab world--a Lebanese trainee psychiatrist's qualitative views on the provision of mental healthcare services for Palestinian refugees in Lebanon and an interview with a consultant psychiatrist on the effects of the Arab spring on the mental health of Libyans. *Psychiatr Danub*, *25 Suppl 2*, S345-349.

Hasin, D. S., O'Brien, C. P., Auriacombe, M., Borges, G., Bucholz, K., Budney, A., . . . Grant, B. F. (2013). DSM-5 criteria for substance use disorders: recommendations and rationale. *Am J Psychiatry*, *170*(8), 834-851. https://doi.org/10.1176/appi.ajp.2013.12060782

Hosker, D. K., Elkins, R. M., & Potter, M. P. (2019). Promoting Mental Health and Wellness in Youth Through Physical Activity, Nutrition, and Sleep. *Child Adolesc Psychiatr Clin N Am*, *28*(2), 171-193. https://doi.org/10.1016/j.chc.2018.11.010

Hossain, K. J., Kamal, M. M., Ahsan, M., & Islam, S. K. N. (2007). Serum antioxidant micromineral (Cu, Zn, Fe) status of drug dependent subjects: Influence of illicit drugs and lifestyle. *Substance Abuse Treatment, Prevention, and Policy*, *2*(1), 12. https://doi.org/10.1186/1747-597X-2-12

Housova, J., Wilczek, H., Haluzik, M. M., Kremen, J., Krizova, J., & Haluzik, M. (2005). Adipocyte-derived hormones in heroin addicts: the influence of methadone maintenance treatment. *Physiol Res*, *54*(1), 73-78.

Hsu, W. Y., Chiu, N. Y., Liu, J. T., Wang, C. H., Chang, T. G., Liao, Y. C., & Kuo, P. I. (2012). Sleep quality in heroin addicts under methadone maintenance treatment. *Acta Neuropsychiatr*, *24*(6), 356-360. https://doi.org/10.1111/j.1601-5215.2011.00628.x

Jaalouk, D., Okasha, A., Salamoun, M. M., & Karam, E. G. (2012). Mental health research in the Arab world. *Soc Psychiatry Psychiatr Epidemiol*, *47*(11), 1727-1731. https://doi.org/10.1007/s00127-012-0487-8

Jeynes, K. D., & Gibson, E. L. (2017). The importance of nutrition in aiding recovery from substance use disorders: A review. *Drug Alcohol Depend*, *179*, 229-239. https://doi.org/10.1016/j.drugalcdep.2017.07.006

Karajibani, M., Montazerifar, F., Dashipour, A., Lashkaripour, K., Abery, M., & Salari, S. (2014). Effectiveness of Educational Programs on Nutritional Behavior in Addicts Referring to Baharan Hospital, Zahedan (Eastern of IR Iran). *Int J High Risk Behav Addict*, *3*(2), e18932. https://doi.org/10.5812/ijhrba.18932

Karam, E. G., Ghandour, L. A., Maalouf, W. E., Yamout, K., & Salamoun, M. M. (2010). A rapid situation assessment (RSA) study of alcohol and drug use in Lebanon. *J Med Liban*, *58*(2), 76-85.

Karam, E. G., Yabroudi, P. F., & Melhem, N. M. (2002). Comorbidity of substance abuse and other psychiatric disorders in acute general psychiatric admissions: a study from Lebanon. *Compr Psychiatry*, *43*(6), 463-468. https://doi.org/10.1053/comp.2002.35910

Kazour, F., Soufia, M., Rohayem, J., & Richa, S. (2016). Suicide Risk of Heroin Dependent Subjects in Lebanon. *Community Ment Health J*, *52*(5), 589-596. https://doi.org/10.1007/s10597-015-9952-7

Kok, G., & Mesters, I. (2011). Getting inside the black box of health promotion programmes using intervention Mapping. *Chronic Illn*, *7*(3), 176-180. https://doi.org/10.1177/1742395311403013

Kolarzyk, E., Chrostek Maj, J., Pach, D., Janik, A., Kwiatkowski, J., & Szurkowska, M. (2005). Assessment of daily nutrition ratios of opiate-dependent persons before and after 4 years of methadone maintenance treatment. *Przegl Lek*, *62*(6), 368-372.

Lee, N. M., Carter, A., Owen, N., & Hall, W. D. (2012). The neurobiology of overeating: Treating overweight individuals should make use of neuroscience research, but not at the expense of population approaches to diet and lifestyle. *EMBO reports*, *13*(9), 785-790.

Lee, N. M., Hall, W. D., Lucke, J., Forlini, C., & Carter, A. (2014). Food addiction and its impact on weight-based stigma and the treatment of obese individuals in the US and Australia. *Nutrients*, *6*(11), 5312-5326.

Lerma-Cabrera, J. M., Carvajal, F., & Lopez-Legarrea, P. (2015). Food addiction as a new piece of the obesity framework. *Nutrition Journal*, *15*(1), 1-5.

Li, J., Yang, C., Davey-Rothwell, M., & Latkin, C. (2016). Associations Between Body Weight Status and Substance Use Among African American Women in Baltimore, Maryland: The CHAT Study. *Subst Use Misuse*, *51*(6), 669-681. https://doi.org/10.3109/10826084.2015.1135950

Mahfoud, Y., Talih, F., Streem, D., & Budur, K. (2009). Sleep disorders in substance abusers: how common are they? *Psychiatry (Edgmont (Pa. : Township))*, *6*(9), 38-42. https://www.ncbi.nlm.nih.gov/pubmed/19855859

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2766287/

Mattick, R. P., Breen, C., Kimber, J., & Davoli, M. (2009). Methadone maintenance therapy versus no opioid replacement therapy for opioid dependence. *Cochrane Database Syst Rev*, *2009*(3), Cd002209. https://doi.org/10.1002/14651858.CD002209.pub2

MENHARA. (2018). *Regional Overview 2.8 Middle East and North Africa. Harm reduction in the Middle East and North Africa*. Menhara.

MENHARA. (2021). *Assessment of situation and response of drug use and its harms in the middle east and north africa*. MENHARA.

Meule, A., & Gearhardt, A. N. (2014). Food addiction in the light of DSM-5. *Nutrients*, *6*(9), 3653-3671. https://doi.org/10.3390/nu6093653

Montazerifar, F., Karajibani, M., & Lashkaripour, K. (2012). Effect of methadone maintenance therapy on anthropometric indices in opioid dependent patients. *Int J High Risk Behav Addict*, *1*(3), 100-103. https://doi.org/10.5812/ijhrba.4968

MOPH. (2014). *Hospital-based cause of death notification system*. Retrieved 15-05-2022 from https://moph.gov.lb/en/Pages/8/20380/hospital-based-cause-of-death-statistics

MOPH. (2016). *Inter-Ministerial Substance UseResponse Prevention, Treatment, Rehabilitation, Harm Reduction, Social Re-integration and Supply Reduction. STRATEGY FOR LEBANON 2016 – 2021*. MOPH.

MOPH. (2017). *National Report on Drug Situation in Lebanon*. MOPH.

Müller, D. J., Muglia, P., Fortune, T., & Kennedy, J. L. (2004). Pharmacogenetics of antipsychotic-induced weight gain. *Pharmacological Research*, *49*(4), 309-329. https://doi.org/https://doi.org/10.1016/j.phrs.2003.05.001

Mysels, D. J., & Sullivan, M. A. (2010). The relationship between opioid and sugar intake: review of evidence and clinical applications. *J Opioid Manag*, *6*(6), 445-452.

Nabipour, S., Ayu Said, M., & Hussain Habil, M. (2014). Burden and nutritional deficiencies in opiate addiction- systematic review article. *Iran J Public Health*, *43*(8), 1022-1032.

Neale, J., Nettleton, S., & Pickering, L. (2012). Heroin users' views and experiences of physical activity, sport and exercise. *Int J Drug Policy*, *23*(2), 120-127. https://doi.org/10.1016/j.drugpo.2011.06.004

NHS National Treatment Agency for Substance Misuse. (2016). *Economic analysis of costs and consequences of the treatment of drug misuse: 2-year outcome data from the National Treatment Outcome Research Study (NTORS)*. NHS.

Novick, D. M., Richman, B. L., Friedman, J. M., Friedman, J. E., Fried, C., Wilson, J. P., . . . Kreek, M. J. (1993). The medical status of methadone maintenance patients in treatment for 11-18 years. *Drug Alcohol Depend*, *33*(3), 235-245.

Okasha, A., Karam, E., & Okasha, T. (2012). Mental health services in the Arab world. *World Psychiatry*, *11*(1), 52-54.

Patel, S. R., & Hu, F. B. (2008). Short sleep duration and weight gain: a systematic review. *Obesity (Silver Spring, Md.)*, *16*(3), 643-653. https://doi.org/10.1038/oby.2007.118

Peles, E., Schreiber, S., & Adelson, M. (2010). 15-Year survival and retention of patients in a general hospital-affiliated methadone maintenance treatment (MMT) center in Israel. *Drug Alcohol Depend*, *107*(2-3), 141-148. https://doi.org/10.1016/j.drugalcdep.2009.09.013

Powers, J. M., Woody, G. E., & Sachs, M. L. (1999). Perceived Effects of Exercise and Sport in a Population Defined by Their Injection Drug Use. *The American Journal on Addictions*, *8*(1), 72-76. https://doi.org/10.1080/105504999306108

Rapeli, P., Fabritius, C., Alho, H., Salaspuro, M., Wahlbeck, K., & Kalska, H. (2007). Methadone vs. buprenorphine/naloxone during early opioid substitution treatment: a naturalistic comparison of cognitive performance relative to healthy controls. *BMC clinical pharmacology*, *7*, 5-5. https://doi.org/10.1186/1472-6904-7-5

Roessler, K. K. (2010). Exercise treatment for drug abuse--a Danish pilot study. *Scand J Public Health*, *38*(6), 664-669. https://doi.org/10.1177/1403494810371249

Saeland, M., Haugen, M., Eriksen, F. L., Smehaugen, A., Wandel, M., Bohmer, T., & Oshaug, A. (2009). Living as a drug addict in Oslo, Norway--a study focusing on nutrition and health. *Public Health Nutr*, *12*(5), 630-636. https://doi.org/10.1017/s1368980008002553

Said, A. M., Okasha, A., Okasha, T., Haroon, A., & Fikry, M. (2012). Quality of Life and Personality Dimensions in Egyptian Substance Dependence Patients. *Addictive Disorders & Their Treatment*, *11*(1), 36-42.

Santolaria-Fernandez, F. J., Gomez-Sirvent, J. L., Gonzalez-Reimers, C. E., Batista-Lopez, J. N., Jorge-Hernandez, J. A., Rodriguez-Moreno, F., . . . Hernandez-Garcia, M. T. (1995). Nutritional assessment of drug addicts. *Drug Alcohol Depend*, *38*(1), 11-18.

Schierenbeck, T., Riemann, D., Berger, M., & Hornyak, M. (2008). Effect of illicit recreational drugs upon sleep: cocaine, ecstasy and marijuana. *Sleep Med Rev*, *12*(5), 381-389. https://doi.org/10.1016/j.smrv.2007.12.004

Spronk, D. B., van Wel, J. H., Ramaekers, J. G., & Verkes, R. J. (2013). Characterizing the cognitive effects of cocaine: a comprehensive review. *Neurosci Biobehav Rev*, *37*(8), 1838-1859. https://doi.org/10.1016/j.neubiorev.2013.07.003

Tang, A. M., Bhatnagar, T., Ramachandran, R., Dong, K., Skinner, S., Kumar, M. S., & Wanke, C. A. (2011). Malnutrition in a population of HIV-positive and HIV-negative drug users

living in Chennai, South India. *Drug Alcohol Depend*, *118*(1), 73-77. https://doi.org/10.1016/j.drugalcdep.2011.02.020

UNODC. (2018). *Worlld drug report 2018. Global overview of drug demand and supply. Latest trends, cross-cutting issues* (E.18.XI.9). U. Nations.

UNODC. (2019). *World drug report 2019. Global overview of drug demand and supply* (E.19.XI.8). U. NATIONS.

UNODC. (2020). *World drug report 2020. Drug supply* (E.20.XI.6). U. NATIONS.

UNODC. (2021). *World drug report 2021. Global overview: Drug demand and supply* (E.21.XI.8). U. NATIONS.

Van Strien, T., Herman, C. P., & Verheijden, M. W. (2009). Eating style, overeating, and overweight in a representative Dutch sample. Does external eating play a role? *Appetite*, *52*(2), 380-387.

Vanderplasschen, W., Colpaert, K., Autrique, M., Rapp, R. C., Pearce, S., Broekaert, E., & Vandevelde, S. (2013). Therapeutic communities for addictions: a review of their effectiveness from a recovery-oriented perspective. *ScientificWorldJournal*, *2013*, 427817. https://doi.org/10.1155/2013/427817

Varela, P., Marcos, A., Ripoll, S., Santacruz, I., & Requejo, A. M. (1997). Effects of human immunodeficiency virus infection and detoxification time on anthropometric measurements and dietary intake of male drug addicts. *The American Journal of Clinical Nutrition*, *66*(2), 509S-514S. https://doi.org/10.1093/ajcn/66.2.509S

Volkow, N. D., Wang, G. J., Tomasi, D., & Baler, R. D. (2013). Obesity and addiction: neurobiological overlaps. *Obesity Reviews*, *14*(1), 2-18.

Wetterling, T., & Müssigbrodt, H. E. (1999). Weight gain: side effect of atypical neuroleptics? *J Clin Psychopharmacol*, *19*(4), 316-321. https://doi.org/10.1097/00004714-199908000-00006

WHO- EMRO. (2016). *Annual report of the Regional Director 2016*. W.-. EMRO.

WHO. (1988). *Draft of chapter 5. Categorie F00 - F99. Mental, behavioural and developmental disorders* (WHO/MNH/MEP/87.1 Rev.2). W. H. ORGANIZATION.

WHO. (1993). *WHO Expert Committee on Drug Dependence [meeting held in Geneva from 28 September to 2 October 1992]: twenty-eighth report*. World Health Organization.

Zahari, Z., Siong, L. C., Musa, N., Mohd Yasin, M. A., Choon, T. S., Mohamad, N., & Ismail, R. (2016). Report: Demographic profiles and sleep quality among patients on methadone maintenance therapy (MMT) in Malaysia. *Pak J Pharm Sci*, *29*(1), 239-246.

Chapter 2

Nutritional status and eating habits of people who use drugs and/or are undergoing treatment for recovery: a narrative review.

Nadine Mahboub, Rana Rizk, Mirey Karavetian, Nanne de Vries

Nutrition Reviews Journal, 2021, 79(6), 627-635.

Nutritional status and eating habits of people who use drugs and/or are undergoing treatment for recovery: a narrative review.

Abstract

A comprehensive overview is presented of the nutritional issues faced by people who use drugs or are undergoing treatment for recovery. Chronic substance use affects a person's nutritional status and body composition through decreased intake, nutrient absorption, and dysregulation of hormones that alter the mechanisms of satiety and food intake. Anthropometrics alone is not the best indicator of nutritional status, because this population has hidden deficiencies and disturbed metabolic parameters. Socioeconomic factors (e.g., higher education, higher income, presence of a partner, living at home) positively affect nutritional status. Scarce available data on users undergoing treatment indicate improvement in anthropometric and metabolic parameters but with micronutrient intake remaining suboptimal. Weight gain is noted especially among women who use drugs and potentially increases their risk of relapse. Finally, specific amino acids and omega-3 fatty acids are promising in decreasing relapse and improving mental health during treatment; however, additional high-quality studies are needed. Nutrition intervention for people who use drugs or are undergoing treatment for recovery is underused; comprehensive programs addressing this population's unique needs are necessary. Future research will identify which components are needed.

Keywords: Substance-related disorders, substance abuse treatment centers, drug users, nutritional status, health promotion.

Introduction

Nearly 5% of the world population is currently estimated to use drugs once daily, and almost 0.6% suffer from severe drug use disorder.[1] To date, opioids are the most harmful type of used drugs, and cannabis remains the world's most widely used drug.[1]

There are various types of treatments used for drug addiction, including detoxification (complete abstinence) or the opioid substitution treatment (OST).[2] Drug detoxification mostly takes place initially in hospitals, followed by psychotherapy and behavioral modification in a therapeutic community or a rehabilitation center.[3] By contrast, OST is a medication-assisted program, during which the patient receives a long-term opioid agonist (methadone or buprenorphine) to reduce the withdrawal symptoms and decrease the cravings for street opioids.[4] OST is suggested to be the most efficient in lowering blood-borne illnesses like infection with the human immunodeficiency virus (HIV) and hepatitis.[5]

Drug use poses a cluster of harmful consequences on a person's wellbeing on the psychological, emotional, and social levels.[6] It leads to increased risk of infectious illnesses,[7] and medical issues including: mental disorders, cancer, stroke, and liver, lung and cardiovascular diseases.[8]

Additionally, substance use can compromise the user's nutrition[2] and greatly affects his/her dietary habits. In general, this population has a disrupted and chaotic lifestyle, where money is usually spent on drugs rather than on food. This severely affects the user's food intake, which eventually leads to undernutrition.[9] Other factors affecting the nutritional status of drug users include the type, frequency, duration of the drug used and the presence of infectious diseases.[10] Furthermore, the type of treatment drug users might be receiving, i.e. being enrolled in a detoxification program and living in rehabilitation centers, versus being on OST and living in the community might also influence their nutritional status.[11]

In this article, the literature on the nutritional issues faced by people who use drugs (PWUD) or those undergoing treatment for recovery will be reviewed, in addition to the effect of drug use on dietary intake and dietary habits. The effect of drugs on anthropometric indices, body composition, nutrient deficiencies, and metabolic parameters will be exposed, in addition to the effect of nutrition on substance use and the changes that occur during treatment and recovery are discussed. The term malnutrition describes a state of imbalance, excess or deficiency that leads to alteration in body composition, negatively affecting the health status of the individual. In this article, malnutrition will be used synonymously with undernutrition.

We chose to conduct a narrative review because there are many different topics in this field with few studies on each and statistical combination is impossible. These data will be compiled to have a comprehensive overview and provide new insights on the drug users' eating patterns for future nutritional interventions in the promotion of good health among this population. Various databases were searched for relevant literature (namely, PubMed, Google Scholar, Science Direct, and Medline), using the following terms: "nutrition" OR "nutritional status" OR "malnutrition" OR "Dietary habits" AND "Illicit drug use" OR "Substance abuse" OR "Drug use*" OR "Drug treatment". The keywords were modified according to the searched database. In addition, references of included articles were reviewed for inclusion when we thought they were relevant. Searches were restricted to English- language journals and a date range of 1990 until the present. A total of 83 studies initially were included in the review. Eight additional studies were suggested by key scholars; accordingly, the total number of the studies included was 91.

Effect of drug use on dietary habits (food preferences, eating behaviors and appetite regulation)

Little research has tackled the issues of food preferences and dietary habits of active drug users or those undergoing different treatment modalities. Cocaine drug users have irregular eating patterns and rely mainly on one meal taken late at night. Typically, this meal is high in refined carbohydrates and fat and low in fruits and vegetables.[12-14] People addicted to opiates replace protein and fats with meals high in sugar and alcohol which are low in essential nutrients, and are therefore sources of empty calories.[9] Substantial evidence supports the increased preferences for sweet taste among people who use drugs (PWUD).[15-20]

During the early phase of detoxification, when patients are still receiving pharmacotherapy, they report a period of low food intake and eating becomes their last priority, as they suffer from nausea, anorexia, and gastrointestinal (GI) disturbances, all of which make eating difficult.[12,19] Between the first and sixth month of detoxification, a high preference and craving for table sugar and sweet foods such as cakes and confectionary foods often takes place as a replacement for the drug. However, in the later recovery phase after six months, sugar cravings seem to level off with more structural food intake and improved appetite.[17,19,21]

Studies of persons receiving OST also show higher preference and intake of sugary foods,[15,22-24] e.g., high consumption of table sugar, yoghurt and soft drinks, with very little intake of fruits and

vegetables.[25,26] Sugary foods appear to be the preferred foods for PWUD or those undergoing treatment. This preference may be an indication of addictive tendencies as some studies show that heroin users have these cravings prior to using heroin more than after using it.[27]

The poor dietary habits decreasing food intake, the preference for sugary foods contributing to empty calories, the compromised liver storage and/or increased excretion of nutrients with accompanying diseases like HIV and hepatitis are major risk factors for malnutrition and hazardous health among PWUD.[28]

Nutrition knowledge seems to affect dietary choices in this population. For instance, when nutrition knowledge was offered as part of an OST program, sugary food craving was still observed, but healthier foods and increased number of meals were consumed by the participants.[18]

Effect of drug use on dietary intake (macro-nutrients and micronutrients)

In the short term, opiates cause anorexia, decreased food consumption, and reduced GI motility, all leading to malnutrition and increased risk of infections in the long term.[29] Socioeconomic factors like education and income are positively associated with nutritional indices like body mass index (BMI), hemoglobin level and serum proteins among PWUD. This association is in agreement with the well-documented fact that socio-economic factors are related to the nutritional status of the individual, in addition to the high prevalence of self-reported homelessness among PWUD.[20,30] Similarly, people who use heroin and cocaine have lower energy and protein intake than non-users.[16,31] This intake seems to decline further with higher intensity and duration of drug use.[10] The presence of disease also appears to affect food intake. HIV-positive drug users have more energy, protein, and fat-deficient diets compared with PWUD who are HIV-negative.[28] The high levels of food insecurity among this population are mainly due to the limited funds, which are usually allocated to the support of their habits rather than food; this leads to serious decrease in intake levels.

Consistent with the lower intakes of nutrient-dense foods in this population, the intake of the majority of vitamins and minerals like thiamin, riboflavin, pyridoxine, folate, vitamin D, vitamin C, magnesium, iron, calcium, zinc, copper, and selenium is below the recommended intake.[32] The nutritional imbalance (higher macro/micronutrient ratio) indicating higher intakes of empty calories, is strongly associated with drug use.[33]

Effect of drug use on plasma nutrient deficiencies

The malnutrition of PWUD, assessed by anthropometric measurements, is not usually very severe; thus, measuring the plasma macronutrients and micronutrients might reveal hidden deficiencies that reflect the decrease in the intake of these nutrients.

Essential nutrients are depleted among PWUD in general.[15] This population exhibits low selenium and potassium levels due to lower muscle mass attributed to malnutrition.[34] Iron deficiency and iron- deficiency anemia are widespread mostly among female PWUD,[35-37] as are low plasma levels of vitamins A, C, D, and E. The latter is inversely correlated with the dose and period of addiction.[16,30,35] These deficiencies are mainly caused by restricted access to foods, in addition to the food choices previously discussed.[16,30,35] Thus, the issue of vitamin and mineral supplementation among PWUD and during treatment requires further consideration.

On the other hand, the plasma levels of some minerals are reported to be higher in this group compared with healthy individuals. This is not due to proper nutrition but is rather attributed to factors unique to PWUD. Higher serum levels of phosphorus, sodium, and magnesium are tentatively attributed to partial dehydration.[15] Similarly, increased serum copper and zinc are due to inflammation, acute fasting, and smoking.[15,34,36]

Effect of drug use on anthropometric indices and body composition

Although scarce, the majority of the literature assessing the nutritional status of drug users mostly points towards malnutrition.[11] The relation between drug use, body weight, and BMI has been addressed in many epidemiological studies, and most of the evidence shows an inverse correlation between these variables.[28,38] On admission to detoxification, up to 70% of PWUD have BMI values below the normal range or weight values that are below the population mean.[10] Similarly, "Ross et al.[35]"showed that 24% of PWUD, within a short period of admission for detoxification exhibited mild to moderate malnutrition based on the Subjective Global Assessment.

In general, the BMI of PWUD is lower than that of non-users. HIV-positive persons who use cocaine have the lowest BMI as compared with users of other drugs or with non-users.[39] It is believed that cocaine suppresses appetite and decreases food intake, and subsequently body weight, by inhibiting dopamine transporters, decreasing reuptake of serotonin, up-regulating the glucocorticoid production, and increasing the cocaine and amphetamine regulated transcript (CART) expression.[40,41] "Cowan et al.[21]" previously supported this finding when reporting that

weight was gained with the cessation of cocaine use. "Ersche et al.[13]" challenged the assumption that cocaine leads to weight loss through appetite suppression; rather, they suggested that metabolic alteration is the cause. Their findings showed that cocaine users had lower body weight and fat mass as compared with non-users, despite reporting higher dietary fat and carbohydrate intake.

People who smoke heroin appear to have a lower BMI and body weight than non-users. This inverse correlation is modulated by the high frequency (>3 times/d) and the route of administration of the drug.[38] The significant negative contribution of smoked heroin to body weight and BMI may be due to faster rate of brain delivery of the drug as compared with injection, snorting or oral ingestion, leading to greater reinforcing effects. Substances like heroin may compete with food in the brain activating reward pathways and increase dopamine receptors' availability, thus suppressing the appetite and leading to lower body weight. This is particularly noted among heroin smokers.[38,42-45]

Mcllwraith et al.[46] showed that heroin users are more prone to being underweight as compared with morphine and amphetamine users, while the latter were at higher risk of being obese as compared with morphine users. This finding is contradictory to the appetite suppressing effect of amphetamine, and its relevance to the general population will need to be investigated by future studies as this increase in obesity was found only in comparison with morphine users and not with a non-drug using control group.[46,47]

Methylamphetamine (MA), a relatively new psychostimulant (the second most widely used drug now after heroin, marijuana, and others) is associated with cardiac and hepatic pathology, neurological impairment, mood disorders, and malnutrition.[48] People dependent on MA have a lower BMI as compared with healthy individuals. This might be due to cognitive deficits, abnormal metabolic activity, duration of MA use, and improper oral health that affects food chewing, thus intake.[48,49] More frequent use of other types of drugs such as marijuana or sedatives showed a weak association with a lower BMI, although this association is statistically not significant.[39,50]

In addition, sex might influence the BMI, weight, and body composition of PWUD. Women who are heavy drug users (i.e., using methadone or injection of drugs >16 times/week) have less body fat and lower BMI as compared with PWUD moderately, or infrequently, and non-users. This difference among different levels of drug use is not present in men.[51] This study by "Cofrancesco et al. [51]" confirms the results of studies that showed a negative relation between drug use and BMI

solely among women and not men.[10,52,53] Furthermore, factors like decreased frequency of food consumption are negatively associated with body weight and BMI. Also, poverty resulting from unemployment, common among PWUD, leads to an inability to purchase nutritious foods and is associated with a low BMI. In addition, multiple drug use can lead to poorer nutritional status due to the appetite-suppressing effect of the drug.[20,28,30]

Interestingly, Richardson et al.[54] showed that BMI alone may not be the best indicator to assess PWUD because there was no association between BMI and the nutritional risk level of PWUD when screened. Using other tools to assess appetite, diet quality, and biochemical parameters better identified nutritional deficiencies to be addressed.[35]

Throughout treatment processes, whether by OST or detoxification, PWUD start to consume healthier foods and more structured meals.[19,21,26] Better dietary habits are seen among those in residential homes where meals are being provided, or later in recovery where food preparation becomes a more sociable and satisfying activity as compared with PWUD who have severe addiction and for whom eating is given little consideration.[19] Table 1 summarizes the factors contributing to changes in anthropometric indices and body composition among PWUD.

Table 1: Factors contributing to lower body weight, BMI, and body composition among drug users

Factor	Finding
Gender	Underweight is more frequent among females as compared with males.
Type of drug	Heroin: Highest percentage of drug users in underweight category. Cocaine: Decrease in weight specific to fat mass with no significant changes in BMI. Amphetamines: Higher risk of obesity in users as compared with morphine users. Methylamphetamines: Lower BMI as compared with non-users.
Frequency and route of administration	Multiple drug use for a long duration is negatively associated with the nutritional status. Smoking has faster delivery of the drug to the brain resulting in a lower BMI as compared with snorting or injection
Food insecurity and poverty	Negative effect on the nutritional status by decreasing body weight, body fat and BMI
Pathological diseases	Add to the severity of malnutrition among drug users.
Treatment	Healthier dietary habits seen in detoxification and OST

BMI: Body mass index; OST: Opioid substitution treatment

Effect of drug use on plasma metabolic parameters

The effect of drug use on plasma parameters has also been studied with emphasis on lipid profile, glucose, Hemoglobin levels and hematocrit. In general, plasma total cholesterol has an inverse relation with drug use. Persons addicted to opium, heroin, and MA addicts have a significant decrease in serum cholesterol level as compared with non-users, but with no change in triglyceride(TG) levels.[49,55-58] By contrast, comparing HIV-positive and HIV-negative injecting drug users (IDUs) with a control group, total cholesterol levels were lower and TG levels were significantly higher in the HIV-positive drug users indicating the possible effect of the disease itself and not the drug use.[28] These findings were backed up by "Maccari et al.[59]" who found that heroin users had significantly lower serum cholesterol and high-density lipoprotein (HDL) levels, and higher TG levels as compared with non-users. The aforementioned decrease in serum lipids could be mainly attributed to malnutrition and weight loss, specifically the loss of abdominal fat, in addition to the presence of liver diseases or HIV that are common among heroin users.

Decreased plasma cholesterol has been associated with many negative psychological behaviors including aggression, depression, and suicide.[60;] however, this remains controversial. Low plasma cholesterol can alter tissue concentration of polyunsaturated fatty acids, the depletion of which has important consequences on modulating the serotonergic and dopaminergic functions that play an important role in the aforementioned behaviors. Yet, to date, a causal relationship has not been shown.[58,61-63]Persons addicted to cocaine who relapsed after detoxification had lower plasma cholesterol values (<160 mg/dl) than those who did not, suggesting an increased vulnerability to the development of behavioral and psychological disorders with low cholesterol levels.[55] Whether these diminished levels are associated with drug craving still needs to be investigated.

Glucose is another parameter that was studied in PWUD and remains not well understood. In a study by Zhang et al, [48] the fasting blood glucose levels of persons addicted to MA were lower than those of control participants. This finding runs in parallel with studies done on animals that reported a direct effect of MA on the pancreas, leading to insulin secretion and induced hypoglycemia.[64] On the other hand, non-insulin dependent persons with diabetes who used opium had higher glycosylated hemoglobin (HbA1c) than did non-users, thereby indicating elevated blood glucose for the previous 3 months.[65] The effect of morphine on glucose has been demonstrated in animals with several mechanisms suggested, like an increase in hormone levels including adrenalin, noradrenalin, corticosterone and glucagon, and these in turn increase blood

glucose levels.[66,67] Among the very few studies on humans, Carey et al.[68] showed that morphine can induce a reduction in the plasma counterregulatory epinephrine response, thus causing hypoglycemia symptoms in healthy individuals without diabetes. More studies are needed to confirm if behavioral factors play a role in the effect of drugs on plasma glucose levels.

Hemoglobin and hematocrit levels in drug users are lower in PWUD than non-users, with the lowest levels seen among multiple drug users, and longer durations of addiction.[30] This finding was related to malnutrition and decreased micronutrient intakes especially iron.[69] The decrease in hemoglobin and hematocrit levels among PWUD is specifically noted among women. This might be because men are institutionalized for a longer period than women and that in turn, correlates with better nutritional status.[32,35]

Nutritional changes during recovery (Detoxification or OST)

In addition to being an effective method in reducing harm, OST or methadone maintenance treatment (MMT) also improves the nutritional status of the drug users, whereby users starting treatment show a significant increase in both BMI and weight.[70,71] The increased weight and BMI are mostly seen in patients with higher education and income, suggesting a positive role of social factors on the nutritional status of PWUD.[20,30,70,72] From the patients' point of view, MMT has a positive impact on their physical health, sleep, and weight gain.[73] They report better appetite, change in taste, and more desire to eat.

PWUD starting MMT show a decreased intake in the majority of the nutrients (i.e., fats, cholesterol, fibers, and some minerals and vitamins) 2 months after beginning treatment, followed by an increase after 9 months.[74] Sex might modulate the effect of MMT on weight gain. Whereas studies show an increase in dietary intake, body weight, BMI, and skin fat folds among men, as compared with a modest weight loss in women,[74] other studies show the opposite where women showed a much greater increase in BMI and weight than men.[75] The reason underlying this significant difference between sexes does not seem to be related to the duration of the treatment and needs additional investigation. The increase in weight and BMI may not be due to the shift towards a healthier eating pattern but might be related to the pharmacological aspect of the treatment itself.[23,75,76] Detoxification also results in increased weight and food intake[77-79] which vary at different recovery stages. In the early stages, binge eating is observed as a result of the replacement of drugs with food. Binging may be related to changes in the eating behaviors of

PWUD after periods of food restriction caused by drugs. In later stages of their recovery PWUD developed a more structured and less frequent over eating habits.[21]

The studies regarding the effect of MMT on some metabolic parameters are limited. After six months of MMT, persons addicted to opioid show an increase in serum levels of leptin, total cholesterol, HDL, and low-density lipoproteins (LDL) compared with serum levels before initiation of the treatment.[70,80] A positive correlation is shown between leptin, BMI, and serum lipids with greater effect among women; this is attributed to the difference in percent body fat mass.

As for micro- and macronutrient intake during MMT or detoxification, an increase in the overall intake of energy, proteins, and carbohydrates occurs with both modalities after initiation of the treatment. Yet, this is followed by a decrease in later stages of recovery, when the food intake starts to become more structured. Interestingly, intake of the majority of the minerals stay below the recommended levels, especially patients with HIV; this could be related to the increased intakes of energy-dense foods, rather than nutrient-dense ones.[24,81]

Personal and environmental factors like decreased physical activity and the purchase of high fat but less expensive foods play a role in the weight gain seen among patients in recovery from drug use, thereby highlighting the need to incorporate exercise and nutrition information as part of the treatment.[82] Exercise reduces stress, anxiety, depression, and decrease drug use in individuals recovering from substance use.[83]

Better nutrition knowledge and healthier eating habits are seen among PWUD in MMT after receiving nutrition lectures as part of the treatment program, although no effect on the BMI and weight gain is seen. This could be because the intervention program emphasized the above factors and did not specifically target weight reduction.[84]

Concerns about weight gain among women drug users in recovery is a potential risk factor for relapse. In a study on 297 women with different ethnicities, recruited from 7 different treatment facilities, Warren et al.[79] reported that 70% of them were concerned about the weight gain during recovery, and 45% were concerned about the relapse because of this gain. One-third of the sample indicated that weight loss was ~~a~~ reason to initiate drug use at the beginning. Similarly, drug use was positively associated with overweight among female adolescents.[85] Data revealing drug users' perceptions about the kind of intervention programs for tackling the weight gain they face during treatment are scarce. Most of the research suggests similarities between women and men in terms

of drug use behaviors; however, significant differences exist that may indicate a need for more sex-specific research in prevention and treatment strategies.[85] On the bases of these findings, giving individualized behavioral recommendations must be considered as all intervention research shows its efficiency. Table 2 summarizes the effect of drug use and treatment on different aspects of the nutritional status of PWUD.

Table 2: Effect of drug use and treatment methods on the nutritional status

	Drug Use	**OST**	**Detoxification**
Food Preferences	Consumption of one meal a day with higher preference for sugars and fats and lower intakes of fruits and vegetables.	Better appetite and increased number of meals. High consumption of sugars, yoghurt and soft drinks with low intakes of fruits and vegetables.	Binging on sweets in early phases of treatment with more structured food intakes in later recovery stages.
Macro/micro nutrient intake	Deficits in energy and protein. Majority of vitamins and minerals below RI.	Higher energy, proteins and carbohydrates after initiation of treatments with a decrease in later stages.	Higher energy, proteins and carbohydrates after initiation of treatments with a decrease in later stages.
Plasma nutrients	Low levels of Se, K, Fe, vitamins A, D, C and E. High levels of Mg, Na, and Ph attributed to dehydration	Majority of micronutrient levels stayed below the recommended levels.	Majority of micronutrient levels stayed below the recommended levels.
Anthropometrics	Decrease in BMI and weight with variations based on the type of drug.	Significant increase in BMI and weight with more significance in females placing them in the overweight category.	Increase in weight and food intake in early stages of recovery.
Metabolic parameters	Low levels of total and HDL-Cholesterol, leptin, FBS, Hct and Hgb.	Increase in total and HDL-Cholesterol and leptin.	

OST: Opioid substitution treatment; BMI: Body mass index; HDL: High density lipoprotein; FBS: Fasting blood sugar; Hct: Hematocrit; Hgb: Hemoglobin; RI: Recommended intake; Fe: Iron; Se: Selenium; K: Potassium; Mg: Magnesium; Na: Sodium; Ph: Phosphorus.

Effect of nutrition on substance use

The high prevalence of PWUD with mood disorders like depression and anxiety has been confirmed by numerous large epidemiological studies[86-88] and these disorders, in turn, might have a negative impact on user's recovery, which will lead to relapse.[15,89] Essential micronutrients play an important role in the mood regulation by the brain,[33] and deficiencies or insufficient intakes of these nutrients, in addition to food deprivation, correlate with poor mental health, especially depression.[90,91] Serotonin plays a role in the modulation of many behaviors like violence, aggression, mood, sleep, appetite, among others.[92,93] The synthesis of serotonin starts with the amino acid tryptophan. Increasing dietary intake of tryptophan can increase serotonin levels, thus modulating the above-mentioned behaviors. Data in the literature concerning the positive effect of tryptophan supplementation on depression are inconsistent; consensus has not yet been reached regarding the effectiveness in the treatment of drug use.[93-95] Tyrosine and phenylalanine are also involved in the synthesis of dopamine and catecholamines that influence the behavioral performances with limited and inconsistent evidence that their supplementation is beneficial in the treatment of PWUD.[15,95,96] When patients dependent on heroin or opiate are given a combination of amino acids (namely, phenylalanine, tryptophan, tyrosine, glutamine) while undergoing detoxification, they show a significant reduction in the craving for opiates.[97] This might be an important tool in the treatment of drug use that warrants additional studies.

The provision of micronutrients is required as a cofactor for the synthesis of serotonin, dopamine and catecholamines.[98,99] Deficiencies of copper, selenium, manganese, magnesium, folate, and B-complex are linked to depression[98,100-102] which might hinder the treatment process of drug users. Vitamin and mineral supplementation should be considered, not only for the management of malnutrition but also as a preventive measure of relapse.

Furthermore, fatty acids are also involved in regulating the aforementioned behaviors.[103,104] Elevated levels of the corticotropin-releasing hormone which is associated with defensive and violent behaviors decrease with supplementation of a combination of omega-3 fatty acid docosahexaenoic (DHA) and eicosapentaenoic (EPA) acids.[105] Patients undergoing detoxification from drug use have a decrease in anger score upon supplementation with DHA, whereas lower anxiety scores are associated with supplementation with EPA.[106]

Supplementation could have a positive effect on the psychological behaviors that might prevent relapse. The intake of specific nutrients like amino acids and omega-3 fatty acids are promising in

decreasing relapse and improving mental health during treatment, but additional high-quality studies are needed to provide evidence that such supplementation can increase the efficacy of the treatment of PWUD.

Conclusion

PWUD are a vulnerable population, and most of the research exploring their nutritional status points to malnutrition. Substance use affects the nutritional status and body composition through decreased food intake and nutrient absorption, altered metabolism, use of multiple drugs, in addition to the dysregulation of hormones altering the mechanism of satiety and food intake. Anthropometric measurements alone are not the best indicators of assessment in this patient population, because active users and those seeking treatment have many hidden deficiencies and disturbed metabolic parameters. Socioeconomic factors like education, income, presence of a partner, and living in a residential home where meals are provided have a positive impact and should be considered.

Scarce available data indicate improvements in the anthropometric and metabolic parameters of PWUD when they initiate treatment, but micronutrient levels remain below recommended intake values. Yet, an increase in weight is noted, which might pose negative health implications.

All of the above factors draw attention to the importance of proper comprehensive nutrition care being provided for drug users and in treatment centers. Simple nutrition education about healthy eating habits improves the quality of the nutritional intake of PWUD but does not seem to be solely effective in treating the problems faced by users and those undergoing treatment and improving their outcomes. This indicates the need for an individualized and comprehensive nutritional intervention. The components of this intervention still need to be determined by future studies.

Acknowledgments

Author's contributions: NM did the literature search, collected and interpreted the data, and drafted the manuscript. RR interpreted the data, wrote original content and critically revised the manuscript. MK and NV wrote original content and critically revised the manuscript. All authors approved the final version of the manuscript.

Funding: None

Declaration of interest: None

References

1. United Nations Office on Drugs and Crime. World drug report 2017: Conclusions and policy implications. UNODC; 2017.
2. Nabipour S, Ayu Said M, Hussain Habil M. Burden and nutritional deficiencies in opiate addiction:Systematic review article. *Iranian Journal of Public Health.* 2014;43(8):1022-1032.
3. Gerstein DR, Lewin LS. Treating drug problems. *New England Journal of Medicine.* 1990;323(12):844-848.
4. Rapeli P, Fabritius C, Alho H, Salaspuro M, Wahlbeck K, Kalska H. Methadone vs. buprenorphine/naloxone during early opioid substitution treatment: A naturalistic comparison of cognitive performance relative to healthy controls. *BMC Clin Pharmacol.* 2007;7:5-5.
5. Caplehorn JR, Ross MW. Methadone maintenance and the likelihood of risky needle-sharing. *The International Journal of the Addictions.* 1995;30(6):685-698.
6. Degenhardt L, Hall W. Extent of illicit drug use and dependence, and their contribution to the global burden of disease. *Lancet..* 2012;379(9810):55-70.
7. Spronk DB, van Wel JH, Ramaekers JG, Verkes RJ. Characterizing the cognitive effects of cocaine: A comprehensive review. *Neuroscience and Biobehavioral Reviews.* 2013;37(8):1838-1859.
8. Volkow ND. Drugs, brains, and behavior: The science of addiction. *NIH Publication*; 2010.
9. Morabia A, Fabre J, Chee E, Zeger S, Orsat E, Robert A. Diet and opiate addiction: A quantitative assessment of the diet of non-institutionalized opiate addicts. *British Journal of Addiction.* 1989;84(2):173-180.
10. Santolaria-Fernandez FJ, Gomez-Sirvent JL, Gonzalez-Reimers CE, et al. Nutritional assessment of drug addicts. *Drug and Alcohol Dependence.* 1995;38(1):11-18.
11. Forrester JE, Tucker KL, Gorbach SL. The effect of drug abuse on body mass index in Hispanics with and without HIV infection. *Public Health Nutrition.* 2007;8(1):61-68.
12. Noble C, McCombie L. Nutritional considerations in intravenous drug misusers: A review of the literature and current issues for dietitians. *Journal of Human Nutrition and Dietetics.* 1997;10(3):181-191.

13. Ersche KD, Stochl J, Woodward JM, Fletcher PC. The skinny on cocaine: insights into eating behavior and body weight in cocaine-dependent men. *Appetite.* 2013;71:75-80.
14. Billing L, Ersche KD. Cocaine's appetite for fat and the consequences on body weight. *The American Journal of Drug and Alcohol Abuse.* 2015;41(2):115-118.
15. Jeynes KD, Gibson EL. The importance of nutrition in aiding recovery from substance use disorders: A review. *Drug and Alcohol Dependence.* 2017;179:229-239.
16. Sæland M, Haugen M, Eriksen FL, et al. High sugar consumption and poor nutrient intake among drug addicts in Oslo, Norway. *British Journal of Nutrition.* 2010;105(4):618-624.
17. Stickel A, Rohdemann M, Landes T, et al. Changes in nutrition-related behaviors in alcohol-dependent patients after outpatient detoxification: The role of chocolate. *Substance Use & Misuse.* 2016;51(5):545-552.
18. Nolan LJ, Scagnelli LM. Preference for sweet foods and higher body mass index in patients being treated in long-term methadone maintenance. *Substance Use & Misuse.* 2007;42(10):1555-1566.
19. Neale J, Nettleton S, Pickering L, Fischer J. Eating patterns among heroin users: A qualitative study with implications for nutritional interventions. *Addiction.* 2012;107(3):635-641.
20. Himmelgreen DA, Perez-Escamilla R, Segura-Millan S, Romero-Daza N, Tanasescu M, Singer M. A comparison of the nutritional status and food security of drug-using and non-drug-using Hispanic women in Hartford, Connecticut. *American Journal of Physical Anthropology.* 1998;107(3):351-361.
21. Cowan J, Devine C. Food, eating, and weight concerns of men in recovery from substance addiction. *Appetite.* 2008;50(1):33-42.
22. Peles E, Schreiber S, Sason A, Adelson M. Risk factors for weight gain during methadone maintenance treatment. *Substance Abuse.* 2016;37(4):613-618.
23. Mysels DJ, Sullivan MA. The relationship between opioid and sugar intake: Review of evidence and clinical applications. *Journal of Opioid Management.* 2010;6(6):445-452.
24. Kolarzyk E, Chrostek Maj J, Pach D, Janik A, Kwiatkowski J, Szurkowska M. Assessment of daily nutrition ratios of opiate-dependent persons before and after 4 years of methadone maintenance treatment. *Przeglad lekarski.* 2005;62(6):368-372.

25. Zador D, Lyons Wall PM, Webster I. High sugar intake in a group of women on methadone maintenance in south western Sydney, Australia. *Addiction).* 1996;91(7):1053-1061.
26. Bogucka-Bonikowska A, Baran-Furga H, Chmielewska K, et al. Taste function in methadone-maintained opioid-dependent men. *Drug and Alcohol Dependence.* 2002;68(1):113-117.
27. Levine AS, Kotz CM, Gosnell BA. Sugars and Fats: The neurobiology of preference. *The Journal of Nutrition.* 2003;133(3):831S-834S.
28. Tang AM, Bhatnagar T, Ramachandran R, et al. Malnutrition in a population of HIV-positive and HIV-negative drug users living in Chennai, South India. *Drug and Alcohol Dependence.* 2011;118(1):73-77.
29. White R. Drugs and nutrition: How side effects can influence nutritional intake. *The Proceedings of the Nutrition Society.* 2010;69:558-564.
30. Nazrul Islam SK, Hossain KJ, Ahmed A, Ahsan M. Nutritional status of drug addicts undergoing detoxification: Prevalence of malnutrition and influence of illicit drugs and lifestyle. *British Journal of Nutrition.* 2007;88(5):507-513.
31. Forrester JE, Tucker KL, Gorbach SL. Dietary intake and body mass index in HIV-positive and HIV-negative drug abusers of Hispanic ethnicity. *Public Health Nutr.* 2004;7(7):863-870.
32. Saeland M, Haugen M, Eriksen FL, et al. Living as a drug addict in Oslo, Norway:A study focusing on nutrition and health. *Public Health Nutr.* 2009;12(5):630-636.
33. Schroeder RD, Higgins GE. You Are What You Eat: The impact of nutrition on alcohol and drug use. *Substance Use & Misuse.* 2017;52(1):10-24.
34. Díaz-Flores JF, Sañudo RI, Rodríguez EM, Romero CD. Serum concentrations of macro and trace elements in heroin addicts of the Canary islands. *Journal of Trace Elements in Medicine and Biology.* 2004;17(4):235-242.
35. Ross LJ, Wilson M, Banks M, Rezannah F, Daglish M. Prevalence of malnutrition and nutritional risk factors in patients undergoing alcohol and drug treatment. *Nutrition.* 2012;28(7):738-743.
36. Hossain KJ, Kamal MM, Ahsan M, Islam SKN. Serum antioxidant micromineral (Cu, Zn, Fe) status of drug dependent subjects: Influence of illicit drugs and lifestyle. *Substance Abuse Treatment, Prevention, and Policy.* 2007;2(1):12.

37. Semba RD, Shah N, Strathdee SA, Vlahov D. High prevalence of iron deficiency and anemia among female injection drug users with and without HIV infection. *J Acquir Immune Defic Syndr.* 2002;29(2):142-144.
38. Li J, Yang C, Davey-Rothwell M, Latkin C. Associations between body weight status and substance use among African American women in Baltimore, Maryland: The CHAT study. *Subst Use& Misuse.* 2016;51(6):669-681.
39. Quach LA, Wanke CA, Schmid CH, et al. Drug use and other risk factors related to lower body mass index among HIV-infected individuals. *Drug and Alcohol Dependence.* 2008;95(1-2):30-36.
40. Di Marzo V, Goparaju SK, Wang L, et al. Leptin-regulated endocannabinoids are involved in maintaining food intake. *Nature.* 2001;410(6830):822-825.
41. Kuhar MJ. CART peptides and drugs of abuse: A review of recent progress. *J Drug Alcohol Res.* 2016;5:235984.
42. Wiss DA. A biopsychosocial overview of the opioid crises: Considering nutrition and gastrointestinal health. *Frontiers in Public Health*. 2019;7:1-52
43. Volkow ND, Fowler JS, Wang GJ, Swanson JM, Telang F. Dopamine in drug abuse and addiction. *Neurological Review.* 2007;64(11):1575-1579.
44. Trinko R, Sears RM, Guarnieri DJ, Dileone RJ. Neural mechanisms underlying obesity and drug addiction. *Physiology & Behavior.* 2007;91(5):499-505.
45. Volkow ND. Stimulant medications: How to minimize their reinforcing effects? *American Journal of Psychiatry*. 2006;163(3):359-361.
46. McIlwraith F, Betts KS, Jenkinson R, Hickey S, Burns L, Alati R. Is low BMI associated with specific drug use among injecting drug users? *Subst Use& Misuse.* 2014;49(4):374-382.
47. Blüml V, Kapusta N, Vyssoki B, Kogoj D, Walter H, Lesch OM. Relationship between substance use and body mass index in young males. *The American Journal on Addictions.* 2012;21(1):72-77.
48. Lv D, Zhang M, Jin X, et al. The body mass index, blood pressure, and fasting blood glucose in patients With methamphetamine dependence. *Medicine.* 2016;95(12):e3152-e3152.

49. Zhang M, Lv D, Zhou W, et al. The levels of triglyceride and total cholesterol in methamphetamine dependence. *Medicine.* 2017;96(16):e6631.
50. Barry D, Petry NM. Associations between body mass index and substance use disorders differ by gender: Results from the national epidemiologic survey on alcohol and related conditions. *Addict Behav.* 2009;34(1):51-60.
51. Cofrancesco J, Jr., Brown TT, Luo RF, John M, Stewart KJ, Dobs AS. Body composition, gender, and illicit drug use in an urban cohort. *The American Journal of Drug and Alcohol Abuse.* 2007;33(3):467-474.
52. Forrester JE, Woods MN, Knox TA, Spiegelman D, Skinner SC, Gorbach SL. Body composition and dietary intake in relation to drug abuse in a cohort of HIV-positive persons. *J Acquir Immune Defic Syndr.* 2000;25 Suppl 1:S43-48.
53. Karmon SL, Moore RD, Dobs AS, Keruly J, Barnett S, Cofrancesco J, Jr. Body shape and composition in HIV-infected women: an urban cohort. *HIV Medicine.* 2005;6(4):245-252.
54. Richardson RA, Wiest K. A preliminary study examining nutritional risk factors, body mass index, and treatment retention in opioid-dependent patients. *The Journal of Behavioral Health Services & Research.* 2015;42(3):401-408.
55. Buydens-Branchey L, Branchey M. Association between low plasma levels of cholesterol and relapse in cocaine addicts. *Psychosomatic Medicine.* 2003;65(1):86-91.
56. Kouros D, Tahereh H, Mohammadreza A, Minoo MZ. Opium and heroin alter biochemical parameters of human's serum. *The American Journal of Drug and Alcohol Abuse.* 2010;36(3):135-139.
57. Fatemi SS, Hasanzadeh, M., Arghami, A. and Sargolzaee, M.R. . Lipid profile comparison between opium addicts and non-addicts. *The Journal of Tehran University Heart Center.* 2008;3(3):169-172.
58. Lin SH, Yang YK, Lee SY, et al. Association between cholesterol plasma levels and craving among heroin users. *Journal of Addiction Medicine.* 2012;6(4):287-291.
59. Maccari S, Bassi C, Zanoni P, Plancher AC. Plasma cholesterol and triglycerides in heroin addicts. *Drug and Alcohol Dependence.* 1991;29(2):183-187.
60. Lehto SM, Hintikka J, Niskanen L, et al. Low HDL cholesterol associates with major depression in a sample with a 7-year history of depressive symptoms. *Progress in Neuro-Psychopharmacology & Biological Psychiatry.* 2008;32(6):1557-1561.

61. Hibbeln JR, Umhau JC, George DT, et al. Plasma total cholesterol concentrations do not predict cerebrospinal fluid neurotransmitter metabolites: Implications for the biophysical role of highly unsaturated fatty acids. *The American Journal of Clinical Nutrition.* 2000;71(1):331S-338S.

62. Brown SL, Salive ME, Harris TB, et al.Low cholesterol concentrations and severe depressive symptoms in elderly people. *BMJ.* 1994;308:1328-1332.

63. Zureik M, Courbon D, Ducimetiere P. Serum cholesterol concentration and death from suicide in men: Paris prospective study 1. *BMJ.* 1996;313:649-651.

64. McMahon EM, Feldman JM, Schanberg SM. Further studies of methamphetamine-induced insulin release. *Toxicology and Applied Pharmacology.* 1975;32(1):62-72.

65. Karam GA, Reisi M, Kaseb AA, Khaksari M, Mohammadi A, Mahmoodi M. Effects of opium addiction on some serum factors in addicts with non-insulin-dependent diabetes mellitus. *Addiction Biology.* 2004;9(1):53-58.

66. Azod L, Rashidi M, Afkhami-Ardekani M, Kiani G, Khoshkam F. Effect of opium addiction on diabetes. *The American Journal of Drug and Alcohol Abuse.* 2008;34(4):383-388.

67. Mahani SE, Motamedi F, Ahmadiani A. Involvement of hypothalamic pituitary adrenal axis on the nifedipine-induced antinociception and tolerance in rats. *Pharmacology Biochemistry and Behavior.* 2006;85(2):422-427.

68. Carey M, Gospin R, Goyal A, et al. Opioid receptor activation impairs hypoglycemic counterregualtion in humans. *Diabetes.* 2017;66(11):2764-2773.

69. Escobar M, Scherer JN, Soares CM, et al. Active Brazilian crack cocaine users: Nutritional, anthropometric, and drug use profiles. *Brazilian Journal of Psychiatry.* 2018;40:354-360.

70. Montazerifar F, Karajibani M, Lashkaripour K. Effect of methadone maintenance therapy on anthropometric indices in opioid dependent patients. *International Journal of High Risk Behaviors & Addiction.* 2012;1(3):100-103.

71. Novick DM, Richman BL, Friedman JM, et al. The medical status of methadone maintenance patients in treatment for 11-18 years. *Drug and Alcohol Dependence.* 1993;33(3):235-245.

72. Alves D. Housing and employment situation, body mass index and dietary habits of heroin addicts in methadone maintenance treatment. *Heroin Addiction and Related Clinical Problems.* 2011;13:11.
73. Kheradmand A, Banazadeh N, Abedi H. Physical effects of methadone maintenance treatment from the standpoint of clients. *Addict Health.* 2010;2(3-4):66-73.
74. Szpanowska-Wohn A, Kolarzyk E, Pach D, Targosz D. Nutritional status of opiate-dependent persons before and during methadone maintenance therapy.*Przeglad lekarski.* 2004;61(4):339-344.
75. Fenn JM, Laurent JS, Sigmon SC. Increases in body mass index following initiation of methadone treatment. *Journal of Substance AbuseTtreatment.* 2015;51:59-63.
76. Haber PS, Elsayed M, Espinoza D, Lintzeris N, Veillard A-S, Hallinan R. Constipation and other common symptoms reported by women and men in methadone and buprenorphine maintenance treatment. *Drug and Alcohol Dependence.* 2017;181:132-139.
77. Orsini CA, Ginton G, Shimp KG, Avena NM, Gold MS, Setlow B. Food consumption and weight gain after cessation of chronic amphetamine administration. *Appetite.* 2014;78:76-80.
78. Hodgkins CC, Cahill KS, Seraphine AE, Frostpineda K, Gold MS. Adolescent Drug addiction treatment and weight gain. *Journal of Addictive Diseases.* 2004;23(3):55-65.
79. Warren CS, Lindsay AR, White EK, Claudat K, Velasquez SC. Weight-related concerns related to drug use for women in substance abuse treatment: Prevalence and relationships with eating pathology. *Journal of Substance Abuse Treatment.* 2013;44(5):494-501.
80. Housova J, Wilczek H, Haluzik MM, Kremen J, Krizova J, Haluzik M. Adipocyte-derived hormones in heroin addicts: the influence of methadone maintenance treatment. *Physiological Research.* 2005;54(1):73-78.
81. Varela P, Marcos A, Ripoll S, Santacruz I, Requejo AM. Effects of human immunodeficiency virus infection and detoxification time on anthropometric measurements and dietary intake of male drug addicts. *The American Journal of Clinical Nutrition.* 1997;66(2):509S-514S.
82. Emerson MH, Glovsky E, Amaro H, Nieves R. Unhealthy weight gain during treatment for alcohol and drug use in four residential programs for Latina and African American women. *Subst Use& Misuse.* 2009;44(11):1553-1565.

83. Collingwood TR, Reynolds R, Kohl HW, Smith W, Sloan S. Physical fitness effects on substance abuse risk factors and use patterns. *Journal of Drug Education.* 1991;21(1):73-84.
84. Sason A, Adelson M, Herzman-Harari S, Peles E. Knowledge about nutrition, eating habits and weight reduction intervention among methadone maintenance treatment patients. *Journal of Substance Abuse Treatment.* 2018;86:52-59.
85. Brecht ML, O'Brien A, von Mayrhauser C, Anglin MD. Methamphetamine use behaviors and gender differences. *Addict Behav.* 2004;29(1):89-106.
86. Regier DA, Farmer ME, Rae DS, et al. Comorbidity of mental disorders with alcohol and other drug abuse. Results from the Epidemiologic Catchment Area (ECA) Study. *JAMA.* 1990;264(19):2511-2518.
87. Grant BF, Stinson FS, Dawson DA, et al. Prevalence and co-occurrence of substance use disorders and independent mood and anxiety disorders: Results from the national epidemiologic survey on alcohol and related conditions. *Archives of General Psychiatry.* 2004;61(8):807-816.
88. Kessler RC, Crum RM, Warner LA, Nelson CB, Schulenberg J, Anthony JC. Lifetime co-occurrence of DSM-III-R alcohol abuse and dependence with other psychiatric disorders in the National Comorbidity Survey. *Archives of General Psychiatry.* 1997;54(4):313-321.
89. Tolliver BK, Anton RF. Assessment and treatment of mood disorders in the context of substance abuse. *Dialogues in Clinical Neuroscience.* 2015;17(2):181-190.
90. Oddy WH, Robinson M, Ambrosini GL, et al. The association between dietary patterns and mental health in early adolescence. *Preventive Medicine.* 2009;49(1):39-44.
91. Alaimo K, Olson CM, Frongillo EA. Family food insufficiency, but not low family income, is positively associated with dysthymia and suicide symptoms in adolescents. *J Nutr.* 2002;132(4):719-725.
92. Benton D. The impact of diet on anti-social, violent and criminal behaviour. *Neuroscience and BiobehavioralRreviews.* 2007;31(5):752-774.
93. Silber BY, Schmitt JA. Effects of tryptophan loading on human cognition, mood, and sleep. *Neuroscience and Biobehavioral Reviews.* 2010;34(3):387-407.

94. Steenbergen L, Jongkees BJ, Sellaro R, Colzato LS. Tryptophan supplementation modulates social behavior: A review. *Neuroscience and biobehavioral Reviews.* 2016;64:346-358.
95. Parker G, Brotchie H. Mood effects of the amino acids tryptophan and tyrosine. *Acta Psychiatrica Scandinavica.* 2011;124(6):417-426.
96. Jongkees BJ, Hommel B, Kuhn S, Colzato LS. Effect of tyrosine supplementation on clinical and healthy populations under stress or cognitive demands:A review. *Journal of Psychiatric Research.* 2015;70:50-57.
97. Chen TJ, Blum K, Payte JT, et al. Narcotic antagonists in drug dependence: Pilot study showing enhancement of compliance with SYN-10, amino-acid precursors and enkephalinase inhibition therapy. *Medical Hypotheses.* 2004;63(3):538-548.
98. Herbison CE, Hickling S, Allen KL, et al. Low intake of B-vitamins is associated with poor adolescent mental health and behaviour. *Preventive Medicine.* 2012;55(6):634-638.
99. Muss C, Mosgoeller W, Endler T. Mood improving potential of a vitamin trace element composition:A randomized, double blind, placebo controlled clinical study with healthy volunteers. *Neuro Endocrinology Letters.* 2016;37(1):18-28.
100. Mlyniec K, Gawel M, Doboszewska U, et al. Essential elements in depression and anxiety. Part II. *Pharmacological Reports : PR.* 2015;67(2):187-194.
101. Pasco JA, Jacka FN, Williams LJ, et al. Dietary selenium and major depression: A nested case-control study. *Complementary Therapies in Medicine.* 2012;20(3):119-123.
102. Almeida OP, Ford AH, Flicker L. Systematic review and meta-analysis of randomized placebo-controlled trials of folate and vitamin B12 for depression. *International Psychogeriatrics.* 2015;27(5):727-737.
103. Garland MR, Hallahan B. Essential fatty acids and their role in conditions characterised by impulsivity. *International Review of Psychiatry (Abingdon, England).* 2006;18(2):99-105.
104. Hallahan B, Garland MR. Essential fatty acids and mental health. *The British Journal of Psychiatry..* 2005;186:275-277.
105. Hibbeln JR, Bissette G, Umhau JC, George DT. Omega-3 status and cerebrospinal fluid corticotrophin releasing hormone in perpetrators of domestic violence. *Biological Psychiatry.* 2004;56(11):895-897.

106. Buydens-Branchey L, Branchey M, Hibbeln JR. Associations between increases in plasma n-3 polyunsaturated fatty acids following supplementation and decreases in anger and anxiety in substance abusers. *Progress in Neuro-psychopharmacology & Biological Psychiatry*. 2008;32(2):568-575.

Chapter 3

People who use drugs in rehabilitation, from chaos to discipline: Advantages and pitfalls: A qualitative study.

Nadine Mahboub, Gladys Honein-Abou Haidar, Rana Rizk, Nanne de Vries

PLOS ONE, 2021, 16(2), 1-17.

People who use drugs in rehabilitation, from chaos to discipline: Advantages and pitfalls: A qualitative study.

Abstract

Evidence-based models emphasizing on lifestyle behaviors for the treatment of drug use is still in its infancy. The development of multicomponent effective drug use intervention programs as part of health promotion is crucial to decrease risk of relapse. This study aims at exploring the lifestyle practices including dietary intake, physical activity and sleep of people who use drugs undergoing residential rehabilitation treatment in Lebanon with its perceived benefits and pitfalls. A purposive sample of 18 males and 9 females at different stages of recovery from drug use in rehabilitation centers participated in the qualitative discussions. The six phases thematic analysis revealed three themes: chaotic lifestyle, structured lifestyle, benefits and pitfalls, and suggestions for making rehabilitation a better experience. Participants discussed their chaotic lifestyle during addiction with poor food intake, disrupted sleep and low physical activity moving to a more disciplined routine enforcing normality in lifestyle practices with social and profession professional support. The early phases of treatment were marked with increased food intake and weight gain perceived as a health indicator and the sole divergent from drugs, moving towards more structured meals and efforts to lose weight in later stages. Lack of variety of Physical activity programs taking into consideration the motivational differences among the participants was also highlighted. Measures for improving rehabilitation services in terms of promoting healthy eating behaviors and environmental control were thoroughly addressed.

These findings shed the light on the challenges faced in maintaining a healthy lifestyle in rehabilitation centers and the necessities of addressing them to improve the overall rehabilitation experience, prevent relapse and inform the development of future targeted intervention programs tackling all aspects of behavioral changes.

Keywords: Substance use disorder, substance use disorder treatment centers, health promotion, healthy lifestyle, Lebanon.

Introduction

Illicit drug use among young people is epidemic and remains a significant public health concern. It poses harmful consequences on the individual's emotional, social and psychological status leading to higher risks for diseases and mental disorders.[1] In addition to this, it is associated with unhealthy lifestyle practices including poor dietary behaviors, changes in physical activity and sleep problems leading to substantial health problems and poor quality of life.

Drug use greatly affects individual's dietary behavior, and compromises their nutritional status[2]. In general, this population has a disrupted and chaotic lifestyle, where money is usually spent on drugs rather than food.[2] Brain changes that occur due to psychological and neurobiological factors in substance use disorder, make cravings for the substance more important than anything else in the person's life.[3]This severely affects the food intake of People Who Use Drugs (PWUD)' where most of them have a low nutrient-dense food intake with sweet cravings[4-6] and decreased body mass index (BMI)[7-10] putting them in a mild to moderate malnutrition status.[11]

Physical activity is another lifestyle practice affected by drug use. The scarce evidence on PWUDs' involvement in physical activity is controversial. Some suggest low participation in structured sports,[12,13]while others show active participation in an attempt to stay healthy and divert from the use of drugs as a self-care strategy.[14-16]

Sleep is negatively affected by drug use.[17,18-20]An estimated 10-15% of people with chronic sleep disturbance have underlying substance use disorders, and this is affected by the type of drug used.[21,20,22]

Once referred to inpatient rehabilitation services, i.e., detoxification followed by psychotherapy and behavioral modification therapies,[23] addressing lifestyle practices and improving the quality of life of PWUD are crucial to decrease the risk of relapse.[24]

During rehabilitation, dietary behaviors and nutritional status fluctuate depending on the stage of recovery.[25] In the early stages, binging on sugars is observed as a replacement for the drugs compared to more structured eating behaviors later.[26-28]

Physical activity is another potential non-pharmacological treatment for substance use disorder.[29] It was shown to reduce sufferings from withdrawals, anxiety, and depression, in addition to improving self-confidence with a sense of the new quality of life.[24,30,31]Nevertheless, the controversy around benefits of physical activity during rehabilitation remains in light of the scarcity of studies exploring this issue.

The sleep of people who use drugs undergoing treatment, especially in rehabilitation services, has also received little attention. The dearth of studies are conducted on persons with opiate addiction receiving methadone treatment, showing inadequate sleep quality and quantity which could arise from a mix of contributory causes like psychopathological problems, nicotine use, duration of opiate use, in addition to methadone itself that produces sleep abnormalities.[21,32,33]Furthermore, attention to proper nutrition could be a key to better sleep during rehabilitation. Studies have shown that specific macronutrients might influence the person's sleep quality. Indeed, there is a negative association between the consumption of foods high in refined carbohydrates, a common practice among people who use drugs in rehabilitation, and sleep duration.[34,35]

Research on best practices for disseminating evidence-based substance use disorder (SUD) treatments into practice is still emerging.[36] Models used for recovery from addiction mainly emphasized on basic pharmaco and psycho-social elements like understanding and accepting self, family and peer support and community envolvement,[37] with little emphasis on lifestyle behaviors tailored to meet the individuals needs and preferences. Emerging evidence continues to shed light on the benefits conferred by physical activity, balanced nutrition and sleep on mental health and wellness, so alternative treatment interventions incorporating these three aspects fashions a comprehensive approach to mental health treatment with numerous benefits.[38] The need for the development of multicomponent effective drug use intervention programs as part of health promotion is crucial to decrease risk of relapse.[37]

The present study was conducted in Lebanon, a small high-middle income country in the Eastern Mediterranean region. Despite the various predisposing factors for drug use including internal and regional armed conflicts for over three decades, studies on drug use patterns in Lebanon are scarce.[39-41] To our knowledge, no previous studies were conducted on the in-patient rehabilitation services offered in the country.

This study aims at exploring the lifestyle practices including dietary intake, physical activity and sleep of PWUD undergoing treatment (detoxification followed by in-patient rehabilitation) in Lebanon and perceived benefits and pitfalls. Ultimately, the findings will inform the development of future targeted intervention programs.

Materials and Methods

Design and approach

This is a descriptive qualitative study based on focus group discussions (FGDs) with a sample of PWUD undergoing treatment in rehabilitation centers in Lebanon. Ethical approval was obtained from the American University of Beirut (SBS-2018-0424) and the Lebanese International University (LIUIRB-180122-NB1) Institutional Review Boards. A written consent was handed and signed by the participants. This consent form explained the purpose of the study, the process of data collection, and that the participants can withdraw from the study at any time. Also, their consent for audio recording the sessions and quoting them in the final manuscript was sought.

Sample

A purposive sampling approach was used to recruit participants from drug rehabilitation centers. The criteria of selection were adult from both genders (above 18 years of age), Lebanese and active people who use drugs seeking treatment. We excluded non-Lebanese participants, as they may have different triggers for addiction and less optimal rehabilitation conditions (e.g., immigrants lacking family support essential for treatment), and participants below the age of 18. Seven FGDs were conducted on participants in rehabilitation centers as they were acquainted with each other and shared a similar experience and setting.

Recruitment and data collection

We approached the seven operating rehabilitation centers in Lebanon. Only three out of seven granted us approval to collect data from their patients. From each center, eligible participants who consented to participate in the discussions were approached and informed about the objectives, the methods of the study, and about their right to withdraw at any time. Two groups of participants were chosen: those who have been in rehabilitation for less than six months (early recovery) and those who completed more than six months (late recovery). The early recovery groups ranged from four to five participants, while the late recovery ones ranged from three to six participants. Two of the centers provide services for males solely and one for females. In total, twenty- nine persons met the eligibility criteria. One person refused to participate, one left during the discussion, and twenty- seven finished the FGDs.

The two researchers NM and GHA introduced themselves to the participants and handed them the written consent. No compensation was offered to the participants for their time spent in the FGDs. A semi-structured discussion guide containing open questions was used; however, probing questions arose to delve into important points raised by the participants (Appendix 1). All discussions were conducted in Arabic and in a private room in the center. One researcher was taking notes and the other was moderating. The discussion was started by asking each participant to introduce him/herself and since participants were acquainted with each other, they discussed their lives freely during addiction and the factors leading them to seek treatment. Followed by this, the moderator guided the discussion reaching the daily routines in the center including assigned chores, their food intake and choices, factors affecting their intake, weight change experiences, sleep and physical activities. Finally, the need for nutrition education in the center and the best way to deliver it was also addressed. All FGDs were conducted before the analysis. Following each FGD, NM and GHA had a debriefing session to discuss the yield. Saturation was reached after seven FGD.

Data analysis

Sociodemographic characteristics were analyzed using SPSS, version 21 Software. All FGDs were transcribed by NM and EM. We used the six phases thematic analysis approach recommended by Braun et al[42] (Appendix 2). Themes and sub-themes were identified by NM and GHA without the use of a qualitative data analysis software, and corresponding quotes were translated and saved in a data repository. Representative quotes were cited in the manuscript. This study followed the consolidated criteria for reporting qualitative studies (COREQ) (Appendix 3).

Increasing rigor

We ensured that credibility and reflexivity were observed. In terms of credibility, focus group moderators shared the same first language for ease of communication. All conversations were audio recorded, transcribed verbatim, translated into English, and used as the main data repository. We invited all the centers that exist in Lebanon, but we conducted 7 FGDs representing all the centers that consented to participate. More importantly, we believe we reached saturation given that no further findings emerged in the final FGD. In terms of reflexivity, to avoid any undue influence, the moderators (GHA and NM) had no prior relationship with participants. Further,

during focus group moderation, the roles of the moderator and observer were disclosed to participants. Finally, all team members were involved in the analysis so as to avoid bias interpretation of the results.

Results

Sociodemographic characteristics of study participants

In total seven FGDs were conducted. Eighteen males and nine females in recovery from substance use disorder in three different rehabilitation centers in Lebanon participated in this study. Demographic information of the sample are detailed in Table 1. Fifty-two percent of the participants fell in the early recovery stage (less than six months). The mean age of the sample was 30.1±6.5 years, with the majority (52%) having a university-level education. All participants were unemployed during rehabilitation, with 74% being single at the time of the assessment. On average, the participants-initiated drug use at the age of 19.48± 18.91, and used drugs for 12.39±7.71 years. The vast majority of the sample (89%) used drugs more than 3 times daily, half of them (52%) injected drugs in addition to other use methods simultaneously. Cocaine was the most frequent drug used, followed by heroin, tranquillizers, and cannabis. Other substances used included pain killers, hallucinogenic, and stimulants.

Table 1: *Demographic Information of Participants of the Focus Group Discussions (FGD).*

		Center 1 (n=9)	Center 2 (n=8)	Center 3 (n=10)	Total (n=27)
Age (mean ±SD)		29.2±6.1	28.6±5.4	32.1±7.7	30.1±6.5
Gender (%)	Male	0 (0)	8 (100)	10 (100)	18 (66.7)
	Female	9 (100)	0 (0)	0 (0)	9 (33.3)
Treatment duration (%)	Early recovery (<6 months)	5 (55.6)	5 (62.5)	4 (40.0)	14 (51.9)
	Late recovery (>6 months)	4 (44.4)	3 (37.5)	6 (60.0)	13 (48.1)
Educational level (%)	Elementary/ intermediate	0 (0)	6 (75.0)	4 (40.0)	10 (37.0)
	Secondary	1 (11.1)	0	2 (20.0)	3 (11.1)
	University	8 (88.9)	2 (25.0)	4 (40.0)	14 (51.9)
Employment (%) (pre-rehabilitation)	Unemployed/ Retired	3 (33.3)	0	2 (20.0)	5 (18.5)
	Employed	3 (33.3)	6 (75.0)	3 (30.0)	12 (44.4)
	Self-employed	1 (11.1)	2 (25.0)	5 (50.0)	8 (29.6)
	Student	1 (11.1)	0	0	1 (3.7)
	No response	1 (11.1)	0	0	1 (3.7)
Marital status (%)	Single	5 (55.6)	8 (100)	7 (70.0)	20 (74.1)
	Married	1 (11.1)	0	0	1 (3.7)
	Divorced/Separated	3 (33.3)	0	3 (30.0)	6 (22.2)
Type of drug use (%)	Drug use only	5 (55.6)	2 (25.0)	4 (40.0)	11 (40.7)
	Drug injection only	1 (11.1)	0	1 (10.0)	2 (7.4)
	Drug use and injection	3 (33.3)	6 (75.0)	5 (50.0)	14 (51.9)
Substances used pre-treatment (%)	Heroin	4 (44.4)	6 (75.0)	8 (80.0)	18 (66.7)
	Cocaine	7 (77.8)	7 (87.5)	8 (80.0)	22 (81.5)
	Crack	6 (66.7)	7 (87.5)	8 (80.0)	21 (77.8)
	Buprenorphine (Tidigesic)	3 (33.3)	5 (62.5)	6 (60.0)	14 (51.9)
	Dextropropoxyphene	1 (11.1)	2 (25.0)	0	3 (11.1)
	Amphetamines	5 (55.6)	5 (62.5)	4 (40.0)	14 (51.9)
	Tranquilizers	5 (55.6)	6 (75.0)	7 (70.0)	18 (66.7)
	Barbiturates	1 (11.1)	3 (37.5)	3 (30.0)	7 (25.9)
	Cannabis	6 (66.7)	6 (75.0)	7 (70.0)	19 (70.4)
	Other	6 (66.7)	5 (62.5)	6 (60.0)	17 (62.9)
Frequency of drug use (%)	More than 3 times daily	9 (100.0)	8 (100.0)	7 (70.0)	24 (88.9)
	One to 3 times daily	0	0	3 (30.0)	3 (11.1)
Age at first use (mean±SD)		29.00±31.69	14.87±1.45	14.60±1.64	19.48±18.91
Duration of drug use (mean±SD)		9.38±5.87	11.00±6.66	16.33±8.93	12.39±7.71

Rehabilitation centers' characteristics

The three rehabilitation centers were mainly governed and subsidized by the Ministry of Social Affairs in Lebanon, except for the medications that were under the jurisdiction of the Ministry of Public Health. The centers shared common criteria for accepting patients including completing a detoxification program prior to admission, willingly accepting to go through rehabilitation, and

being free of any contagious disease such as tuberculosis. A urine test is required to confirm detoxification, and is done prior to admission. Once admitted, patients needed to follow strict discipline in terms of sleeping hours, meal time, occupational tasks, and restricted access to television and social media. Further, they were not allowed to go out for three months, after which they were allowed occasional supervised visits to their families. Following each visit, a urine test is done to rule out the use of drugs. At the women's center, children were not allowed to stay with their mothers. They only see them during visitation, which is allowed after three months of admission.

The care providers are social workers, psychologists and psychiatrists offering evidence- based services such as social programs, cognitive behavior therapy, and pharmacotherapy. At one center, patients received Christo therapy which is a faith-based intervention focusing on prayers as a mean to overcome craving and addiction.

Emerging themes

The yield of the discussions can be summarized into the following three themes: chaotic lifestyle: reasons and consequences of drug use, structured lifestyle, benefits and pitfalls, and suggestions for making rehabilitation a better experience. Within each theme, we identified several sub-themes and we noted when they differed by gender and recovery stage.

Chaotic lifestyle: reasons and consequences of drug use

Sub-themes

1- *"We're not used to tackling life without drugs."*

For most participants, drugs were the way out from low self-esteem, depression and stressful experiences in life, such as family conflicts. Drug use was the gateway for fitting in with friends and family members. There were few exceptions particularly two females who indicated that weight gain was the trigger for drug use, while two others started as a result of chronic pain and usage of pain killers.

"I started my drug use in my teenage, I wanted to keep pace with our generation, and that's how it went." (0410; female 26 years)

"After I got out of here, I relapsed again because of my weight gain." (0407; female 36 years)

2- Chaotic lifestyle "No discipline, no discipline, no time, nothing, nothing."

Eating habits were messed up. Most indicated rarely eating and were craving mainly for carbohydrates. All preferred to spend the money on drugs rather than food. Sleeping patterns were also chaotic, where drugs had deleterious consequences leading to disrupted sleep. Consequently, many had major health complications.

"Mostly, its sugar, bonbons and juices" (0410; female 26 years).

Only two participants practiced physical activity during their substance use disorder period. One male had a passion and interest for competitive sports but despite this, participation levels tended to cutail dramatically once heavy drug consumption set in. On the other hand, one female reported that she had routinely participated in physical activity despite her substance use disorder, which in turn played a role in preventing extreme weight loss as a result of the drugs.

"*I took a personal trainer and nutrition course before I started my addiction. I used to go to competitions in sports. When I started drugs, my weight changed from 88 to 55Kg. I was depressed, stayed at home all times and stopped going to the gym." (0207; male 19 years)*

3- Reasons and motivations for rehabilitation "Got sick of the life with drugs."

Most participants had a tipping point leading to rehabilitation, for some extrinsic, for others intrinsic factors. Three participants stated being coerced by legal authorities to seek treatment and fear of imprisonment led them to rehabilitation. Five others indicated that family and peers motivated them to seek treatment.

"At first, I had to be admitted to a rehab because of the drug court." (0409; female 26 years)

Fear was the internal driver to seek treatment for three participants. Mainly it was the fear of losing a job or losing a life due to overdose. Many indicated being fed-up with the chaotic lifestyle that led them to rehabilitation. For others, remorse after relying on violence or theft to acquire the drug triggered this desire to seek help for drug cessation.

"I got fed up and tired of the life of drugs; I wanted to save myself." (0302; male 24 years)

Five participants indicated that because they had a relapse from previous rehabilitation experience, they were challenged to pursue further treatment.

Females specifically noted that treatment was the only way not to lose the custody of a child. Three of the participants were mothers; two had already lost the custody of a child because of drug

addiction, while the third one was pregnant during addiction. All wanted to regain or resume their roles as mothers after treatment.

Structured lifestyle, benefits and pitfalls

The shift from chaotic to structured lifestyle was the hallmark for this period.

In rehabilitation, participants became more connected to daily life routines, had more social and professional support. This period was characterized as mostly very welcomed albeit its pitfalls.

Sub-themes

1- Eat, exercise and sleep. "Our daily routine."

All participants reported living a more structured lifestyle. The mornings started by waking up early and meeting for breakfast followed by completing their assigned chores like cleaning, cooking, or gardening. After lunch, they did recreational tasks like arts especially for females, psychotherapy meetings, followed by dinner and early sleep.

During the early stages of recovery (1-6 months), this lifestyle helped them gain weight. This was perceived as an indicator of health replacing what they lost during addiction; and this in turn increased their self-confidence and self-image

"I gained 16 Kg in two months, huge number." (0410; female 26 years)

"I'm actually satisfied that I'm putting on some weight." (0304; male 23 years)

Eat

Meals were part of the disciplined lifestyle as participants described having three communal meals at a fixed time. Most participants in the early stages of rehabilitation (1-6 months) expressed that they ate large amounts of food during meals and craved for sweet and junk foods that were used as a replacement for drugs.

"*Outside rehab I used to eat a sandwich; here I have my full breakfast. At lunch, instead of eating a plate, I eat two or three. Some people around here binge eat as a way to overcome the stress and need for drugs." (0401; female 23 years)*

Some blamed their binging on food on their frustration from the strict environment in the rehabilitation centers; they ate out of boredom. Eating became the only source of diversion from drugs. Four participants stated that the menu offered in the center was healthy and constituted of

vegetables, grains and some proteins when available. Three others perceived the high amount of carbohydrates given and little protein with no limited portions as unhealthy.

"The food here is way better than food outside, it's healthier." (0209; male 21 years)

"The available foods are not so healthy." (0405; female 25 years)

Females showed frustration regarding the weight gain, and to some this was a reason for relapse. In the late recovery stage (6-12 months), meal structuring became a part of their daily routine and food was no more seen as a substitute for drugs where most participants reported some struggle in terms of food intake control. Consciousness of the weight gain and desire to lose the extra weight was frequently expressed in this stage of the treatment. Weight gain and increased food intake was no more seen as a health indicator, rather as a cause for some for-drug relapse leading to frustration and self-hatred.

"I see people suffering from their extra weight. If I ever put that weight on, I would do drugs for a month to lose that extra weight and then I'll quit." (0212; male 37 years)

Exercise

Physical activity is a mandatory daily or weekly routine in all centers. Participants had a positive attitude towards physical activity and indicated marked physical, psychological and craving benefits from it. On the other hand, some reported that it was a daily routine that was not enjoyed and boring.

"It is a repetition, every week it is the same, it is a routine: running, stretching." (0407; female 36 years)

Sleep

Upon admission, all participants suffered from poor sleep. In the rehabilitation, their sleeping patterns were more disciplined in terms of timing and duration. Excessive sleeping hours especially during the day was reported to the caregivers as it was perceived as a sign of improper coping and possible relapse to drugs. Some females expressed the need for more sleeping hours.

2-Therapy

In terms of therapy, in the religious centers, prayers (Christo-therapy) played a major part of the treatment. Psychotherapy was also included in the daily routine, where weak points of the participants leading to relapse were identified and worked upon.

3-Support system

Most participants pointed to three types of support: social environment, professional and peer. This support was very important in helping participants hold back their cravings for food and drugs.

Creating a supportive social environment included close monitoring of potential triggers to drug use. This type of support embedded security and safety within participants for sustainability and drug relapse prevention.

Most of the participants expressed their gratitude to the excessive professional support and care offered by the care providers through active listening, empathy and lack of judgement and hostility.

Peer support was also cited as a positive supporting system to cope with mainly craving. The pre-set knowledge of the obstacles that will be faced in the different stages of the treatment insured better coping within the participants in addition to them supporting other peers in their first experience. This applied largely to the increased food intake, sweet cravings and weight increase that was faced in the early stages of the treatment, in addition to drug craving.

Suggestions for making rehabilitation a better experience

Whilst residential rehabilitation treatment centers provide a stable environment to target multiple health risk behaviors, these services tend to focus mainly on the drug and alcohol use disorders of the individuals. Other factors like smoking, healthy eating and exercise should be addressed and tackled as part of the daily routine. The participants expressed the need to tailor a program addressing three needs:

1-Nutrition

Two types of suggestions emerged. One in relation to environmental control and the second was promoting healthy eating behaviors. Participants expressed the need to have "*healthy snacks"* available at all times as a means to decrease the sweet cravings and limit the food intake to healthy choices. Others expressed that the rehabilitation centers should have "*dietitians setting healthy*

daily menus with emphasis on portion control" as a means to control the weight gain experienced. However, strict discipline was not recommended in the first stages as they have enough rules and having more may offset individuals.

"A nutrition intervention program" in treatment centers that provides general nutrition education to all participants in the early stages of the treatment (0-6 months) was desired. An important aspect of this program is to raise awareness about the increase in food intake and weight that the participants might face during the treatment.

In later stages (6-12 months), having an "*individualized consultation"* to members in need of weight monitoring or loss was expressed.

"Start with general information about nutrition and then it becomes individualized." (0303; male 36 years)

2- *Physical Activity*

Participants expressed the need for more varied physical activity programs to be administered in the afternoons rather than mornings because this was when craving for drugs was intensified

"In the morning you wake up calm, but in afternoon you have cravings so sports are very important." (0401; female 23 years)

3-Transitional programs post-rehabilitation

Some participants emphasized on the need to have transitional programs post-rehabilitation where coaching sessions are delivered to prevent relapse.

"All drug user needs follow up. Every person who leaves the center today will relapse if not now maybe after a year. We need to stay protected. The one who wants to stop drug abuse has to stay protected all his life. He needs follow up all his life. "(0207; male 19 years).

"Table 2" summarizes more specific quotes related to themes and their subthemes.

Table 2: *Specific quotes corresponding to the themes and their sub-themes*

Theme	Subtheme	Quotes
Chaotic lifestyle	*"We're not used to tackling life without drugs"*	*"My addiction started because of my parents' problems and divorce." (0406; female 40 years)*
		"I wanted to have friends older than me and got used to drugs." (0306; male 24 years)
		"Everyday depression." (0201; male 42 years)
		"My siblings do drugs too." (0407; female 36 years)
		"At first, I had gallbladder disease and because of medications I started drugs." (0407; female 36 years)
	Chaotic lifestyle "No discipline, no discipline, no time, nothing, nothing."	*"Drugs suppress[ed] appetite" (0308; male 28 years)*
		"I became anorexic, I now weigh 37 kg and I have no power left in me." (0410; female 26 years).
		I was depressed, stayed at home all times and stopped going to the gym." (0207; male 19 years)
		"I used to go to a dietitian before and during my addiction. I kept doing sports during my addiction that is why my weight did not change." (0405; female 25 years)
	Coerced "Got sick of the life with drugs."	*"Got out of prison, stayed home then back to prison again." (0307; male 32 years)*
		"I travelled to Africa and ran out of drugs, so I went back to Lebanon and I was advised by my uncle to go to a rehab center so I can get my life together." (0406; female 40 years)
		"We got sick of the life with drugs, it was painful, and we went through a lot, we have tried many ways to overcome drug addiction and there was no other solution. Most of us here are well educated and well aware that addiction is a disease of no cure but rehab." (0203; male 38 years)
		"I don't steal; how did I do that to my parents? What affected me the most is the way I talked with my father, I snapped and told him: I will break the fridge and the TV, just give me the money." (0306; male 24 years)
		"Many times, I have packed my bag to be admitted to a rehab and then I would leave and go back home. I've let my parents down a lot." (0307; male 32 years)
Structured lifestyle, benefits and pitfalls	*Eat, exercise and sleep. "Our daily routine."*	*"We wake up in the morning, pray, have breakfast, do chores assigned to us, attend a meeting, take a break, sometimes there will be no meetings to be held, this basically depends on the program. If so, then we run more errands assigned to each. At noon, we go out to evangelize and have lunch afterwards. We then drink our coffee and we exercise. We take a break, have a bath, then we either have dinner or hold a meeting right before dinner. We sometimes get our own free time after dinner and this*

		depends on the schedule. We then say our prayers and go straight to bed. That's our daily routine." (0304; male 23 years)
		"Coming from a free world where you have access to coffee, soft drinks wherever you are and then all of a sudden you have a structured life, this is frustrating." (0403; female 31 years)
		"The food here is way better than the food outside. It's healthier." (0209; male 21 years)
		***"The available** foods are not so healthy." (0405; female 25 years)*
		"I was never satisfied with my weight gain; I cry day and night." (0405; female 25 years)
		"Yes, a bit of weights, a bit of stretching, a bit of cardio. In summer it is very nice we play basketball, volleyball, football. Stuff like that, and we also go for other activities in summer, so we enjoy the weekend." (0401; female 23 years)
		"Whoever sleeps a lot during the day is noticed by the management. To them, this person is facing issues in the treatment, so they speak to him privately to determine his weakness and work on it." (0208; male 24 years)
		"I need someone to wake me up like four times in the morning." (0401; female 23 years)
		"Do you need more sleep?" (Facilitator) "Yes." (0401 & 0403; females 23 and 31 years)
	Therapy	*"When I arrived here, I was in a very bad shape, I had no communication with others, and I was introverted. Yet, as soon as you arrive, they start working on your weaknesses and boost your self-confidence. They also set goals for whoever is afraid of confronting his/her fear." (0209; male 21 years)*
Suggestions for making rehabilitation a better experience	*Nutrition*	*"I feel that what is wrong in this center is that instead of giving sweets as a snack to the person who is hungry or asking him to wait till the next meal, he/she should be given an apple or a banana to stop the feeling of hunger and to stop him/her from the continuous thinking of food." (0401; female 23 years)*
		"we have rules and we do not want more to be added" (0403; female 31 years)
	Physical activity	*"Would you prefer to have physical activity first thing in the morning, or it does not matter?" (facilitator)* *"In the afternoon. When I do sports, it's the only time I do not have drug cravings" (0403; female 31 years)*

Discussion

This study is among the first to briefly shed the light on the lifestyle of PUWD including eating, sleep and exercise behaviors during addiction with more emphasis on the early and late stages of rehabilitation. Participants described their disciplined lifestyle in rehabilitation centers, which were overall well-received. But they identified pitfalls which, if not properly addressed, may lead some to relapse. They suggested measures for improving rehabilitation services.

Our participants discussed factors leading to substance use disorder and rehabilitation that are echoed in the literature.[43-46] Further, lifestyle practices during addiction including low food and poor nutrient intakes,[2,26,47] lack of engagement in physical activity, as well as disrupted sleep due to the pronounced effect of drugs on wakefulness are also reported globally.[19,20,22]

We found that residential rehabilitation centers provide a stable environment to prevent relapse. The focus is mainly on pharmacotherapy and psychotherapy as means for preventing relapse; and secondly on enforcing a disciplined routine to regain normality in lifestyle practices. While the former seem to be overall well-received, the latter was a blanket approach, not addressing individuals' preferences, thus suboptimal and in need of being redressed. Empowering individuals to gain a healthy lifestyle practice during rehabilitation is important to prevent relapse as our participants indicated. In fact, binge eating and weight gain were associated with relapse, especially among females[48,49]; and lack of sleep may be bidirectional: drug use causes sleep disturbances and difficulty sleeping causes relapse.[50] Thus, providing person-centered interventions including personal coaching in rehabilitation centers by way of preventing relapse are suggested as essential components in treatment facilities.[51,52]

In terms of eating practices, in the early stage of rehabilitation, binge eating is sometimes the sole divergent from drugs.[48,53,54] Effective measures for controlling food intake may include pairing nutritional programs with leisure/vocational activities, to establish healthy eating behaviors while simultaneously increasing self-worth through actively working with individuals and identifying skills and vocations effaced during addiction. Further, establishing nutrition educational programs with emphasis on increasing knowledge, and changing attitudes and practices to promote positive nutrition behaviour[26,51] could help preventing relapse.[55]

Physical activity is another lifestyle behavior poorly addressed in rehabilitation centers in Lebanon. Our participants almost marginalized the role of physical activity by labeling it as 'boring'. It is an essential element as it reduces relapse and withdrawal sufferings while improving

sleep.[21,30,56] It also has a positive effect on the psycho-social wellbeing of individuals,[24,56] where a growing body of literature suggests that it yields mental health and wellness benefits. Brown et al.[58] addressed this gap in the literature and developed an exercise intervention as an adjunct to addiction treatment for drug dependent patients. This study demonstrated benefits in increasing days of abstinence from drugs and alcohol. However, it was challenging to enroll participants in this study, and meet the physical demands of the program. Precise recommendations on the type, amount and frequency of physical activity remains elusive and further studies should consider the adverse effect besides the benefits.[59,38] Interventions to incent individuals to participate in physical activities, while improving the quality and variety of programs are highly recommended. Fun Sports that encourage team work and communication tend to have an appeal for some participants and serve as a forum for the practice of social skills and the development of friendships with other recovering individuals. Understanding motivational differences among participants is a key determinant of engagement and adherence.[13,29,60] Thus, when identifying the type and level of physical activity, it is important to have them person-centered, i.e., taking into consideration individuals' self-efficacy, readiness, and preference of the type of activity offered.

The benefits conferred by physical activity, proper nutrition and adequate sleep have been independently associated with better mental health and physical wellbeing in substance use disorder. These benefits occur through multicomponent effects on the neurobiological and psychosocial development. Studies evaluating strategies to enhance maintenance of treatment have devoted little attention to lifestyle modification, and information related to this area is still scarce.[58] Investigating the impact of interventions related to these lifestyle domains within clinical practices to enhance treatment and prevent relapse is highly recommended.[38]

Follow-up treatment in the community beyond the rehabilitation center is crucial to decrease the risk of relapse among users, and was expressed as a need among most of our participants. There is accumulating evidence suggesting the association between the length of the treatment modality and drug use relapse. The longer the treatment (6-12 months), the less the relapse.[61] The research indicates the need to investigate further the factors that contribute to sustaining a decrease in drug use and negative behaviors post-treatment.

Study strengths and limitations

This study pioneered in tackling the lifestyle practices of PWUD undergoing treatment in rehabilitation centers in Lebanon through qualitative research in the absence of any quantitative data. There are several strengths and limitations that are worth noting. This study fills a gap in the international literature on the lifestyle of PWUD undergoing residential rehabilitation. The research team was composed of two female members: NM and GHA who are located in Lebanon. GHA, the qualitative methodologist, worked with NM, a researcher in health promotion, on developing the predetermined open-ended questions to guide the discussion and conducted interviews. Our evaluation employed several techniques to ensure reflexivity and to increase the credibility of the study: securing a high proportion of potentially eligible individuals to participate, using transcribed audio-recorded interviews, and using participants' quotes to support our findings. Furthermore, the attrition rate in this study was low as twenty-seven out of the twenty-nine who were invited to participate enrolled in this study and finished it. Both researchers have no prior rapport with the participants or the rehabilitation centers.

As for the limitations, female participants were less represented compared to the males and this goes back to the limited number of rehabilitation centers in Lebanon that accommodate females.

Factors associated with poor lifestyle behaviors including psychotropic medications and cigarette smoking were not adequately addressed. Furthermore, it is possible that because participants were still actively involved in the rehabilitation services when collecting the data, their responses may have been more socially desirable to avoid offending their host institution. Finally, there is a limited generalizability of the results, because of the non-random sample and the contextual restrictions where only three rehabilitation centers granted us access.

Implications for future research

Residential treatment centers are controlled environments with potential for offering and implementing healthy lifestyle intervention programs to its residents. Policies for better treatment to PWUD talking all aspects of behavioral changes can be developed from extensive research in this population group. Further research in assessing the nutritional status and healthy behaviors of people who use drugs in rehabilitation centers are required for the development and implementation of a multidisciplinary intervention program in the promotion of good health among this population group. Also, it is important to test the evidence generated by this qualitative

research through quantitative ones, ultimately to come out with an evidence based multifaceted intervention.

Conclusion

PWUD undergoing treatment in rehabilitation centers are a vulnerable population with many challenges. Treatment services mainly concentrate on the medical management of withdrawal and its complications with little emphasis on other treatment modalities. In this study, we shed the light on some of the challenges PWUD face in maintaining a healthy lifestyle in rehabilitation centers and the necessities of addressing those challenges in order to improve the overall rehabilitation experience and prevent relapse.

Supporting information

S1 Appendix. Study guide

Gender:

Age:

Marital Status:

<u>Focus group Guide Questions</u>

1- Tell me a little about yourself and why you are here
2- Let us talk about your daily routine
3- What do you usually eat?
4- Who selects the food?
5- Who cooks the food?
6- Let us talk about the effect of the drug/treatment on the food intake and food choices
7- Let us talk about other factors that you feel affects your food intake
8- What do you think about your individual and group eating habits?
9- Let us talk about your experiences with weight change
10- How do you feel about your weight?
11- What in your opinion causes the weight loss/ gain?
12- What do you think about having information on healthy eating?
13- What are you interested in knowing about food and nutrition?
14- What do you think is the best way to gain such information?
15- Let us talk about exercise
16- What type of exercise do you do?
17- Would you like to do more exercise as part of the program?
18- What ideas do you have to increase exercise?

S2 Appendix. Thematic inductive analytical approach

Adopted from: Braun V, Clarke V. Using Thematic Analysis in Psychology. Qualitative Research in Psychology.2006:77-101

Data was thematically analyzed along six phases.

Phase 1: The interviewers and coder read and re-read each transcript to get acquainted with the information.

Phase 2: An initial list of codes was generated.

Phase 3: The search for themes started. The interviewer and coder discussed the relationships between codes. A log of potential themes and sub-themes was developed, including a list of definitions and quotes to illustrate each theme and sub-theme.

Phase 4: The list of themes was further refined based on consensus reached among all research team members to define themes and sub-themes and highlight the existing relationships between these themes.

Phase 5: Defining and refining the themes was done, that is we identified the story behind each theme and the relationship between themes.

Phase 6: The findings were presented in a narrative form, and a synthesis of the results was included. These findings were supported with quotes from interviewees and beneficiaries relating to identified themes and sub-themes. In this stage, every effort was made to provide a concise, coherent, logical, non-repetitive, and interesting account of the story the data tell – within and across themes.

S3 Appendix. Consolidated criteria for reporting qualitative studies (COREQ): 32-item checklist.

Developed from: Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*. 2007. Volume 19, Number 6: pp. 349 – 357.

No. Item	Guide questions/description	Reported on Page #
Domain 1: Research team and reflexivity		
Personal Characteristics		
1.Interviewer/facilitator	Which author/s conducted the interview or focus group?	Pages 9 & 24
2. Credentials	What were the researcher's credentials? e.g., PhD, MD	Page 24
3. Occupation	What was their occupation at the time of the study?	N/A
4. Gender	Was the researcher male or female?	Page 24
5. Experience and training	What experience or training did the researcher have?	Page 24
Relationship with participants		
6.Relationship established	Was a relationship established prior to study commencement?	N/A
7. Participant knowledge of the interviewer	What did the participants know about the researcher? e.g., personal goals, reasons for doing the research	N/A
8. Interviewer characteristics	What characteristics were reported about the inter viewer/facilitator? e.g., Bias, assumptions, reasons and interests in the research topic	Page 24
Domain 2: Study design		
Theoretical framework		
9. Methodological orientation and Theory	What methodological orientation was stated to underpin the study? e.g., grounded theory, discourse analysis, ethnography, phenomenology, content analysis	Page 5
Participant selection		
10. Sampling	How were participants selected? e.g., purposive, convenience, consecutive, snowball	Page 4
11. Method of approach	How were participants approached? e.g., face-to-face, telephone, mail, email	Page 5
12. Sample size	How many participants were in the study?	Pages 4,5
13. Non-participation	How many people refused to participate or dropped out? Reasons?	N/A
Setting		
14. Setting of data collection	Where was the data collected? e.g., home, clinic, workplace	Page 4

15. Presence of non-participants	Was anyone else present besides the participants and researchers?	N/A
16. Description of sample	What are the important characteristics of the sample? e.g., demographic data, date	Page 5
Data collection		
17. Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	Page 4 and Appendix 1
18. Repeat interviews	Were repeat interviews carried out? If yes, how many?	N/A
19. Audio/visual recording	Did the research use audio or visual recording to collect the data?	Page 4
20. Field notes	Were field notes made during and/or after the interview or focus group?	Page 4
21. Duration	What was the duration of the inter views or focus group?	N/A
22. Data saturation	Was data saturation discussed?	Page 4
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction?	N/A
Domain 3: Analysis and findings		
Data analysis		
24. Number of data coders	How many data coders coded the data?	N/A
25. Description of the coding tree	Did authors provide a description of the coding tree?	N/A
26. Derivation of themes	Were themes identified in advance or derived from the data?	Page 5
27. Software	What software, if applicable, was used to manage the data?	N/A
28. Participant checking	Did participants provide feedback on the findings?	N/A
Reporting		
29. Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g., participant number	Pages 6-12
30. Data and findings consistent	Was there consistency between the data presented and the findings?	Pages 13-15
31. Clarity of major themes	Were major themes clearly presented in the findings?	Pages 6-12
32. Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	Pages 13-15

Author Contributions

Conceptualization: Nadine Mahboub, Rana Rizk, Nanne de Vries
Data curation: Nadine Mahboub, Gladys Honein- Abou Haidar
Formal analysis: Nadine Mahboub, Gladys Honein- Abou Haidar
Funding acquisition: Rana Rizk
Investigation: Nadine Mahboub, Gladys Honein- Abou Haidar
Methodology: Nadine Mahboub, Gladys Honein- Abou Haidar, Nanne de Vries
Resources: Nadine Mahboub, Gladys Honein- Abou Haidar
Supervision: Gladys Honein- Abou Haidar, Rana Rizk, Nanne de Vries
Writing- original draft: Nadine Mahboub, Gladys Honein- Abou Haidar
Writing- review & editing: Rana Rizk, Nanne de Vries

References

1. Volkow ND. Drugs, brains, and behavior:The science of addiction. NIH Publication.2010.
2. Nabipour S, Ayu Said M, Hussain Habil M. Burden and nutritional deficiencies in opiate addiction- systematic review article. Iranian journal of public health. 2014;43(8):1022-1032.
3. Cunningham PM. The use of sobriety nutritional therapy in the treatment of opioid addiction. J Addict Res Ther. 2016; 7(282): 10-4172
4. Stickel A, Rohdemann M, Landes T, et al. Changes in nutrition-related behaviors in alcohol-dependent patients after outpatient detoxification: the role of chocolate. Substance Use & Misuse. 2016;51(5):545-552.
5. Jeynes KD, Gibson EL. The importance of nutrition in aiding recovery from substance use disorders: a review. Drug and Alcohol Dependence. 2017;179:229-239.
6. Sæland M, Haugen M, Eriksen FL, et al. High sugar consumption and poor nutrient intake among drug addicts in Oslo, Norway. British Journal of Nutrition. 2010;105(4):618-624.
7. Santolaria-Fernandez FJ, Gomez-Sirvent JL, Gonzalez-Reimers CE, et al. Nutritional assessment of drug addicts. Drug and Alcohol Dependence. 1995;38(1):11-18.
8. Lv D, Zhang M, Jin X, et al. The body mass index, blood pressure, and fasting blood glucose in patients with methamphetamine dependence. Medicine. 2016;95(12):e3152-e3152.
9. Lin SH, Yang YK, Lee SY, et al. Association between cholesterol plasma levels and craving among heroin users. Journal of Addiction Medicine. 2012;6(4):287-291.
10. Tang AM, Bhatnagar T, Ramachandran R, et al. Malnutrition in a population of HIV-positive and HIV-negative drug users living in Chennai, South India. Drug and Alcohol Dependence. 2011;118(1):73-77.
11. Ross LJ, Wilson M, Banks M, Rezannah F, Daglish M. Prevalence of malnutrition and nutritional risk factors in patients undergoing alcohol and drug treatment. Nutrition. 2012;28(7):738-743.
12. Neale J, Nettleton S, Pickering L, Fischer J. Eating patterns among heroin users: a qualitative study with implications for nutritional interventions. Addiction (Abingdon, England). 2012;107(3):635-641.

13. Abrantes AM, Battle CL, Strong DR, et al. Exercise preferences of patients in substance abuse treatment. *Mental Health and Physical Activity*. 2011;4(2):79-87.
14. Rene D. Drumm DM, Lisa Metsch,Melodie Neufeld, Alex Sawatsky. "I'm a health nut!" street drug users' accounts of self-care strategies. The Journal of Dug Issue. 2005;35(3):607-630.
15. Powers JM, Woody GE, Sachs ML. Perceived effects of exercise and sport in a population defined by their injection drug use. The American Journal on Addictions. 1999;8(1):72-76.
16. Fischer J, Butt C, Dawes H, et al. Fitness levels and physical activity among class A drug users entering prison. British Journal of Sports Medicine. 2012;46(16):1142-1144.
17. Duterte M, O'Neil S, McKearin G, Sales P, Murphy T, Murphy S. Walking the tightrope: balancing health and drug use. Journal of Psychoactive Drugs. 2001;33(2):173-183.
18. Gossop MR, Bradley BP, Brewis RK. Amphetamine withdrawal and sleep disturbance. Drug and Alcohol Dependence. 1982;10(2-3):177-183.
19. Mahfoud Y, Talih F, Streem D, Budur K. Sleep disorders in substance abusers: how common are they? Psychiatry (Edgmont). 2009;6(9):38-42.
20. Schierenbeck T, Riemann D, Berger M, Hornyak M. Effect of illicit recreational drugs upon sleep: cocaine, ecstasy and marijuana. Sleep Medicine Reviews. 2008;12(5):381-389.
21. Stein MD, Herman DS, Bishop S, et al. Sleep disturbances among methadone maintained patients. Journal of Substance Abuse Treatment. 2004;26(3):175-180.
22. Conroy DA, Arnedt JT. Sleep and substance use disorders: an update. Current Psychiatry Reports. 2014;16(10):487.
23. Gerstein DR, Lewin LS. Treating drug problems. New England Journal of Medicine. 1990;323(12):844-848.
24. Gimenez-Meseguer J, Tortosa-Martinez J, de los Remedios Fernandez-Valenciano M. Benefits of exercise for the quality of life of drug-dependent patients. Journal of Psychoactive Drugs. 2015;47(5):409-416.
25. Forrester JE, Tucker KL, Gorbach SL. The effect of drug abuse on body mass index in Hispanics with and without HIV infection. Public Health Nutrition. 2007;8(1):61-68.
26. Cowan J, Devine C. Food, eating, and weight concerns of men in recovery from substance addiction. Appetite. 2008;50(1):33-42.

27. Varela P, Marcos A, Ripoll S, Santacruz I, Requejo AM. Effects of human immunodeficiency virus infection and detoxification time on anthropometric measurements and dietary intake of male drug addicts. The American Journal of Clinical Nutrition. 1997;66(2):509S-514S.
28. Kolarzyk E, Chrostek Maj J, Pach D, Janik A, Kwiatkowski J, Szurkowska M. Assessment of daily nutrition ratios of opiate-dependent persons before and after 4 years of methadone maintenance treatment. Przeglad lekarski. 2005;62(6):368-372.
29. Abrantes A, Blevins C. Exercise in the Context of Substance Use Treatment: key issues and future directions. Current Opinion in Psychology. 2019;30.
30. Roessler KK. Exercise treatment for drug abuse--a Danish pilot study. Scandinavian Journal of Public Health. 2010;38(6):664-669.
31. Bardo MT, Compton WM. Does physical activity protect against drug abuse vulnerability? Drug and Alcohol Dependence. 2015;153:3-13.
32. Peles E, Schreiber S, Adelson M. Documented poor sleep among methadone-maintained patients is associated with chronic pain and benzodiazepine abuse, but not with methadone dose. *European neuropsychopharmacology :*The Journal of the European College of Neuropsychopharmacology. 2009;19(8):581-588.
33. Beswick T, Best D, Rees S, Bearn J, Gossop M, Strang J. Major disruptions of sleep during treatment of the opiate withdrawal syndrome: differences between methadone and lofexidine detoxification treatments. Addict Biol. 2003;8(1):49-57.
34. Peuhkuri K, Sihvola N, Korpela R. Diet promotes sleep duration and quality. Nutrition Research. 2012; 32: 309-319
35. Lindseth G, Lindseth P, Thompson M. Nutritional effects on sleep.Western Journal of Nursing Research. 2011; 35(4): 497-513.
36. Miller WR, Sorensen JL, Selzer JA, Brigham GS. Disseminating evidence-based practices in substance abuse treatment: a review with suggestions. Journal of Substance Abuse Treatment. 2006;31(1):25-39.
37. Davidson L, Andres-Hyman R, Bedregal L, Tondora J, Frey J, Kirk TA. From “Double Trouble” to “Dual Recovery”: integrating models of recovery in addiction and mental health. Journal of Dual Diagnosis. 2008;4(3):273-290.

38. Hosker DK, Elkins RM, Potter MP. Promoting mental health and wellness in youth through physical activity, nutrition and sleep. Child Adolesc Psychiatric Clin N Am. 2019; 28: 171-193.
39. Ghandour LA, El Sayed DS, Martins SS. Prevalence and patterns of commonly abused psychoactive prescription drugs in a sample of university students from Lebanon: an opportunity for cross-cultural comparisons. Drug and Alcohol Dependence. 2012;121(1-2):110-117.
40. Karam EG, Ghandour LA, Maalouf WE, Yamout K, Salamoun MM. A rapid situation assessment (RSA) study of alcohol and drug use in Lebanon. The Lebanese Medical Journal. 2010;58(2):76-85.
41. Karam EG, Maalouf WE, Ghandour LA. Alcohol use among university students in Lebanon: prevalence, trends and covariates. The IDRAC university substance use monitoring study (1991 and 1999). Drug and Alcohol Dependence. 2004;76(3):273-286.
42. Braun V, Clarke V. Using thematic analysis in psychology. Qualitative Research in Psychology. 2006;3(2):77-101.
43. Wood AP, Dawe S, Gullo MJ. The role of personality, family influences, and prosocial risk-taking behavior on substance use in early adolescence. Journal of Adolescence. 2013;36(5):871-881.
44. Lo CC, Stephens RC. Arrestees' perceived needs for substance-specific treatment: exploring urban-rural differences. The American Journal of Drug and Alcohol Abuse. 2002;28(4):623-642.
45. Warner BD, Leukefeld CG. Rural-urban differences in substance use and treatment utilization among prisoners. The American Journal of Drug and Alcohol Abuse. 2001;27(2):265-280.
46. Lindberg MA, Zeid D. Interactive pathways to substance abuse. Addict Behav. 2017;66:76-82.
47. Emerson MH, Glovsky E, Amaro H, Nieves R. Unhealthy weight gain during treatment for alcohol and drug use in four residential programs for Latina and African American women. Subst Use Misuse. 2009;44(11):1553-1565.

48. Warren CS, Lindsay AR, White EK, Claudat K, Velasquez SC. Weight-related concerns related to drug use for women in substance abuse treatment: prevalence and relationships with eating pathology. Journal of Substance Abuse Treatment. 2013;44(5):494-501.
49. University ncoaasaCac. Food for thought:substance abuse and eating disorders. Colombia University;2003.
50. Hsu WY, Chiu NY, Liu JT, et al. Sleep quality in heroin addicts under methadone maintenance treatment. Acta Neuropsychiatrica. 2012;24(6):356-360.
51. Karajibani M, Montazerifar F, Dashipour A, Lashkaripour K, Abery M, Salari S. Effectiveness of educational programs on nutritional behavior in addicts Referring to Baharan Hospital, Zahedan (Eastern of IR Iran). International Journal of High Risk Behaviors & Addiction. 2014;3(2):e18932-e18932.
52. Copeland J, Martin G. Web-based interventions for substance use disorders: a qualitative review. Journal of Substance Abuse Treatment. 2004;26(2):109-116.
53. Orsini CA, Ginton G, Shimp KG, Avena NM, Gold MS, Setlow B. Food consumption and weight gain after cessation of chronic amphetamine administration. Appetite. 2014;78:76-80.
54. Hodgkins CC, Cahill KS, Seraphine AE, Frostpineda K, Gold MS. Adolescent drug addiction treatment and weight gain. Journal of Addictive Diseases. 2004;23(3):55-65.
55. Grant BF, Stinson FS, Dawson DA, et al. Prevalence and co-occurrence of substance use disorders and independent mood and anxiety disorders: results from the National Epidemiologic Survey on Alcohol and Related Conditions. Archives of General Psychiatry. 2004;61(8):807-816.
56. Zschucke E, Heinz A, Strohle A. Exercise and physical activity in the therapy of substance use disorders. The Scientific World Journal. 2012;2012:901741.
57. Kessler RC, Crum RM, Warner LA, Nelson CB, Schulenberg J, Anthony JC. Lifetime co-occurrence of DSM-III-R alcohol abuse and dependence with other psychiatric disorders in the National Comorbidity Survey. Archives of General Psychiatry. 1997;54(4):313-321.
58. Brown RA, Abrantes AM, Raed JP, Marcus BH, Jakiciic J, Strong DR, et al. A pilot study of aerobic exercise as an adjunctive treatment for drug dependence. Mental Health and Physical Activity. 2010; 3: 27-34.

59. Wolff E, Gaudlitz K, VonLindenberger BL, Plag J, Heinz A, Strohle A. exercise and physical activity in mental disorders. Eur Arch Psychiatry Clin Neurosci. 2011; 261(2):S186-S191.

60. Williams D, Strean W. Physical activity as a helpful adjunct to substance abuse treatment. Journal of Social Work Practice in The Addictions. 2004;4:83-100.

61. Hubbard RL, Craddock SG, Anderson J. Overview of 5-year followup outcomes in the drug abuse treatment outcome studies (DATOS). Journal of Substance Abuse Treatment. 2003;25(3):125-134.

Chapter 4

Nutritional parameters and lifestyle practices of people who use drugs undergoing treatment for recovery in Lebanon: A descriptive study.

Nadine Mahboub, Rana Rizk, Nanne de Vries

Journal of Nutritional Science, 2021, 10(e16), 1-12.

Nutritional parameters and lifestyle practices of people who use drugs undergoing treatment for recovery in Lebanon: A descriptive study.

Abstract

Once people who use drugs (PWUD) are referred to treatment, addressing their lifestyle practices and improving their quality of life improves treatment outcomes.

This study assessed the nutritional status and lifestyle practices among PWUD undergoing treatment for recovery in Lebanon. Furthermore, it explored significant differences in these parameters depending on the offered treatment modality, namely opioid substitution treatment (OST) and rehabilitation. 187 PWUD undergoing treatment for recovery participated in this cross-sectional study. Nutritional status and anthropometrics, dietary intake, nutrition knowledge, food addiction, biochemical parameters, sleep, and physical activity were measured using validated tools. Of the participants, 88.8% were well nourished based on the Subjective Global Assessment. 67% gained weight during treatment placing them in the overweight category. This increase in weight was significantly higher in the rehabilitation group. It came in parallel with higher protein and energy intakes, higher rate of food addiction, and poor nutrition knowledge. Biochemical parameters, including fasting blood sugar, total protein, lipid profile, and white blood cell count, were in the normal ranges. Moreover, the majority of participants exhibited poor quality sleep that was accentuated among the participants undergoing rehabilitation, in addition to activity levels that were mainly low in the OST group. PWUD undergoing treatment for recovery in Lebanon are subject to various vulnerability factors creating challenges to treatment. Longitudinal assessments to better understand health problems arising during treatment, and to identify the components of a comprehensive health promotion intervention during treatment for recovery are needed.

Keywords:

Drug use disorder; drug abuse treatment centers; health promotion; healthy lifestyle; nutritional status; Lebanon.

Introduction

Illicit drug use is one of the most important public health hazards worldwide with 0.6% of the world population suffering from severe drug use disorder. Specifically, among young people, illicit drug use has reached epidemic proportions[1]. Drug use corresponds with unhealthy lifestyle practices and often results in a variety of adverse social and health consequences[2, 3].

Once referred to treatment, whether via opioid substitution treatment (OST) or rehabilitation (detoxification or complete abstinence), addressing the lifestyle practices and improving the quality of life of people who use drugs (PWUD) seems to decrease the risk of relapse[4]. While undergoing treatment for recovery, a major shift occurs in the lifestyle of PWUD especially concerning nutrition and metabolism[5].

The increasingly available time comes to be filled with overeating, often resulting in significant weight gain, varying at different recovery stages[6-10]. Yet, the intake of the majority of micronutrients remains below the recommended levels, which could be related to the increased intake of energy-dense foods, rather than nutrient-dense ones[11,12]. This issue remains understudied and the possibility of having hidden nutrient deficiencies in this population needs further investigations. The literature regarding the effect of treatment on metabolic parameters is also limited. After six months of methadone maintenance treatment (MMT), opioid addicts show metabolic disturbances, such as increased serum total cholesterol and low-density lipoproteins (LDL) compared with pre-treatment levels[6, 13]. This elevation is associated with increased serum leptin levels and not with dietary intake and lifestyle practices.

The sleep of PWUD undergoing treatment, especially in rehabilitation services, has also received little attention in the scientific literature. The dearth of studies conducted on opiate addicts receiving MMT shows inadequate sleep quality and quantity, which could arise from a mix of causes including, psychopathological problems, nicotine use, duration of previous opiate use, in addition to methadone itself that produces sleep abnormalities[14-16]. During periods of drug withdrawal, total sleep time is decreased and sleep latency is increased. This disruption can persist for years post-treatment precipitating a possible relapse to addiction[17, 18]. This issue is yet to be adequately addressed through large-scale studies across different treatment modalities.

Physical activity is another potential, non-pharmacological, element of treatment for addiction[19]: it reduces sufferings from withdrawals, anxiety, and depression, in addition to improving self-confidence with a sense of the new quality of life [4, 20, 21]. Nevertheless, the controversy around the

engagement of PWUD who are undergoing treatment for recovery in physical activity and the benefits of such activity remains in light of the scarcity of studies exploring this issue.

Treatment for substance use disorders mainly involves a combination of pharmacotherapy and psychotherapy approaches. Yet, there is a limited focus on improving nutrition and lifestyle practices that might enhance the outcomes of the treatment. While rehabilitation centers provide a controlled environment with the potential for offering healthy lifestyle practices due to the strict discipline in sleeping hours, mealtime, occupational tasks, and restricted access to television and social media, OST centers do not provide these comprehensive services and involve greater reliance on pharmacological tools for treatment[22]. Exploring the nutritional parameters and lifestyle practices of PWUD across both treatment modalities is essential to identify problematic areas and design targeted health promotion interventions.

Lebanon is a small high-middle income country in the Eastern Mediterranean region that suffered from internal and regional armed conflicts for more than three decades. These conflicts were predisposing factors for drug use due to its wide availability in the Lebanese market with the absence of control over its consumption[1].

This study aims to assess the nutritional parameters, namely nutritional status and anthropometrics, dietary intake, nutrition knowledge, food addiction, and biochemical profiles, as well as different lifestyle practices, including sleep and physical activity, among PWUD undergoing treatment for recovery in Lebanon. We also focus on exploring the major significant differences in these parameters between the offered treatment modalities, namely OST and rehabilitation.

The in-patient residential rehabilitation centers are governed by the Ministry of Social Affairs in Lebanon. Acceptance is conditioned by a complete detoxification program that is confirmed by a urine test prior to admission. The centers follow a strict discipline in terms of sleeping hours, meal times, and tasks performed. Occasional supervised family visitation is allowed after three months of treatment initiation. Following each visit, a urine test is done to rule out the use of drugs. At the women's center, children are not allowed to stay with their mothers and are only seen during visitation. The duration of treatment in the centers is one year.

The out-patient OST centers are under the jurisdiction of the Ministry of Public Health in Lebanon. Guidelines for acceptance are set by the ministry and include mainly previous failures in complete detoxification and rehabilitation. The patients visit the center weekly to take the prescription of buprenorphine (opiate agonist) that is conditioned by a clean opiate urine test. Furthermore,

random urine testing for buprenorphine is done to confirm the proper use of the medication. Treatment duration is individualized depending on the progress of the patient.

The team of care providers in both treatments consists mainly of social workers, psychologists and psychiatrists offering evidence-based behavioral therapy and pharmacotherapy. Medications are prescribed on individual basis if needed and include: antidepressants, antipsychotics, bipolar drugs and others. Illicit drugs used by participants prior to treatment include: opiates, cannabis, stimulants, tranquilizers and barbiturates.

There is evidence of an increase in substance use in Lebanon from the onset of the civil war, particularly among the youth, with a prevalence higher than the global average[23]. Lebanon serves as a transit country for trafficking illicit drugs, in addition to local production and cultivation[24]. At the same time, Lebanon hosts WHO-designed knowledge hubs related to PWUD for the region[24]. The findings will inform the development of future targeted intervention programs aimed at enhancing the lifestyle practices and improving the quality of life of PWUD undergoing treatment for recovery. They ultimately contribute to improving treatment outcomes and decreasing the risk of relapse.

Methods

Study Design and population

We conducted this cross-sectional study in drug treatment facilities offering OST and institutionalized rehabilitation services post-detoxification in Lebanon. Randomly selecting the facilities was not an option since only three out of four OST centers and four out of seven rehabilitation centers operating in the country granted us entry permission. We, thus, targeted a convenience sample. We approached all PWUD receiving treatment in the OST and rehabilitation centers that granted us entry permission and informed them about the objectives, the methods of the study, and their right to withdraw at any time. The criteria for the participants to be included in the study were: 1) To be Lebanese, 2) To be above 18 years of age, 3) To be receiving treatment for more than 1 month. In total, 369 people were approached, 214 accepted to participate in this study (response rate: 57.9%), and 187 subjects met the inclusion criteria. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the Lebanese International University's Committee on Research Ethics (CRE) (case number: LIUIRB- 180122-NB. Written informed consent was obtained from all subjects.

Sample size

We performed a statistical power analysis prior to the start of the study using the sample size and power analysis option of the Epi Info 7 software. Following an expected frequency of suboptimal nutritional status (the main outcome of interest) of 50%, a 10% confidence limit, a design effect of 1.5, and a confidence level of 95%, 138 participants were needed (69 from OST and 69 from rehabilitation centers). Due to the lack of data on the frequency of malnutrition in this patient-population, we used a frequency of 50% to result in the largest sample size. We inflated the sample size by 20% based on the response rate reported in similar studies (rehabilitation: 87-91%[25]; OST: 80-90%[26], leading to a minimum required sample size of 166 participants. As 187 participants were included, the actual power was 92.6%.

Data collection

The study took place between January 2018 and March 2019 in the treatment facilities. Trained licensed dietitians assessed the participants for anthropometrics, conducted the 24-hour dietary recall, and administered the questionnaires. All questionnaires were administered in Arabic (the native language of the participants). A licensed phlebotomist drew the blood samples, and a licensed nurse measured the blood pressure (BP). Data collection required 40 to 50 minutes per participant.

Study parameters included:

- Demographics, medical history, and history of drug use were explored using a questionnaire focusing on sociodemographic characteristics, disease profile, medications, frequency and types of drugs used, duration of drug use, and the type of drug treatment chosen. These questions were based on elements found in the literature associated with the nutritional status, eating habits, and lifestyle of PWUD or those undergoing treatment for recovery.
- Nutritional status was assessed using the Subjective Global Assessment (SGA)[27, 28]. The SGA is a clinical technique which assesses the nutritional status based on five features of the medical history (weight loss and its rate, dietary intake in relation to the participant's usual intake patterns, presence of significant gastro-intestinal symptoms, functional capacity and metabolic requirements of underlying disease) and four features of physical examination (loss of subcutaneous fat, muscle wasting, edema, and ascites). Based on the

score of the above measurements, the nutritional status is classified as well-nourished (A), moderately malnourished (B), or severely malnourished (C).

- Self-reported weight change (kg) was assessed as the difference between reported usual pre-treatment body weight (kg) and measured body weight (kg) at the day of the assessment.
- Anthropometrics: 1) height (cm) using a portable digital wall mounted height scale measured to the nearest 0.1 cm without shoes; 2) weight (kg) using a calibrated mechanical floor scale without shoes and with light clothes on; 3) Body Mass Index (BMI) calculated as the ratio of weight (kg) and height squared (m^2); 4) waist and neck circumferences measured to the nearest 0.1 cm, using a girth measuring tape; 5) body composition (%fat, %muscle mass, and %visceral fat) measured with a BOCA X1 body composition analyzer (Medigate, Korea); and 6) BP (mmHg) using a standardized mercury sphygmomanometer (ALPK2, Japan) in the seated position after five minutes of rest, without prior smoking and exercise on that day. Two consecutive readings of systolic blood pressure (SBP) and diastolic blood pressure (DBP) were taken on the same arm within a two-minute interval. The mean of the two measurements was used for analysis.
- Dietary intake was assessed using the 24-hour food recall using the United States Department of Agriculture's Multiple Pass Food Recall (MPR), which attenuates the recall bias[29, 30]. In order to retrieve forgotten eating occasions and foods, the dietitian probed the participants more than once during the interview to provide comprehensive information about their intake and assist in portion size. Daily energy, macronutrient, and micronutrient intake of the participants were computed from the 24-hour recalls using the food composition database of the Nutritionist Pro software (Nutritionist Pro, Axxya Systems, San Bruno, CA, USA, version 5.1.0, 2018). The software from the database was expanded by adding an analysis of locally consumed foods and recipes[31]. Given that there are no gender or age-specific Dietary Reference Intakes (DRIs) for the Middle Eastern populations, values arising from the analyzed data were compared to the US-based DRIs, as recommended by the Institute of Medicine (Dietary Reference Intake Tables).
- Nutrition knowledge was assessed using the Consumer-Oriented Nutrition Knowledge Questionnaire (CoNKQ) adapted from Spillmann and Keller[32]. This is a validated questionnaire, with good internal reliability (Cronbach's alpha is 0.743), criterion, and

construct validity. It consists of 20 comprehensive questions derived from consumer interviews and expert recommendations about healthy eating.

- Food addiction was assessed using the Yale Food Addiction Scale (YFAS)[33]. This is a highly reliable scale (Cronbach's alpha: 0.84) developed to identify individuals who are most likely to be exhibiting signs of addiction towards certain types of foods (high fat and high sugar). It consists of 27 items that assess food patterns over the past 12 months and translates the criteria of substance dependence for at least one year in relation to eating behaviors including symptoms of tolerance and withdrawal, vulnerability in social activities, etc.
- Biochemical parameters: a blood sample of 5 ml was drawn and samples centrifuged directly by a portable tabletop machine and transported to the laboratory using a thermally insulated box. All blood collection was done early in the morning after an overnight fast after which breakfast was offered to the participants. Serum was analyzed for complete blood count (CBC), fasting blood sugar (FBS (mg/dl)), total protein (g/dl), serum albumin (g/dl), cholesterol (mg/dl), high density lipoprotein-cholesterol (HDL (mg/dl), low density lipoprotein-cholesterol (LDL (mg/dl), triglycerides (TG (mg/dl)), aspartate aminotransferase (AST (IU/L)), and alanine aminotransferase (ALT (IU/L)).
- Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI) developed by Buysse et al.[34] This is a nine-item questionnaire, where four questions assess the duration of sleep, duration needed to fall asleep, the time needed to wake up, and awake time spent in bed, in addition to five other questions assessing the reasons for troubled sleep. Answers are converted to a total score using an algorithm adopted from the developers of the questionnaire, with higher scores (≥ 5) indicating poor sleep quality and lower scores (0-4.9) indicating good sleep quality.
- Physical activity level was assessed using the International Physical Activity Questionnaire (IPAQ) short form[35]. The questionnaire consists of seven questions assessing the duration and frequency of light, moderate, and vigorous physical activity completed in the past seven days. The metabolic equivalent of tasks (METs) were calculated by multiplying the total minutes spent in the corresponding actions with the frequency (days) and the constants of 3.3, 4, and 8 for light, moderate and vigorous activity, respectively. The total MET value

was computed by summing up the respective MET values for all activities that were done in bouts but were longer than 10 minutes in duration.

The Arabic version of the PSQI, culturally-adapted by Haidar et al.[36], was used; whereas, the CoNKQ, YFAS, and IPAQ were translated back and forth by two independent expert bilingual translators. Furthermore, the translated versions of these questionnaires were pilot tested on a group of participants from different treatment centers for validation, the results of which were discarded[37].

Statistical analysis

We conducted the statistical analysis using the Statistical Package for Social Sciences (SPSS) version 21. We performed descriptive analyses to summarize the participants' characteristics through means and standard deviation for continuous variables, and frequencies and percentages for categorical ones. Normality of the data was tested using the Kolmogorov-Smirnov Test. We assessed the significant differences of study parameters between the two treatment modalities using Chi-square test for categorical variables, and Independent Samples T-Test for the continuous variables with normal distribution, and Mann-Whitney U Test for variables with skewed distribution. We considered a p-value <0.05 as statistically significant. The same analyses were conducted after excluding female participants, and differences in the results compared with the initial analyses (total sample) are reported.

Results

Demographics, medical history and history of drug use

In total, 187 PWUD undergoing treatment for recovery (OST: n=97; rehabilitation: n=90) participated in the study. Basic demographic information and medical history of the sample is presented in Table 1. Among the 187 participants, 92.0% were males with the significant majority coming from the OST group (OST: 96.9%; rehabilitation: 86.7%; $p<0.05$). The mean age of the participants was 32.0±8.3 years, only 5.3% were illiterate, and the majority received at least an intermediate level of education. One-quarter of the participants were using antidepressants (25.7%); this finding was more common in the rehabilitation group (OST: 17.5%; rehabilitation: 34.4%; $p< 0.05$). This difference was no longer seen when females were excluded. More than one-third of them were on antipsychotic drugs (38.5%) and 22.5% on epilepsy-bipolar medications,

with a significantly higher percentage of use in the rehabilitation group (OST: 11.3%; rehabilitation: 34.4%; $p<0.05$).

Table 1: Demographics characteristics and medical history of the participants (n=187)

	OST (n=97)		Rehabilitation (n=90)		p-value	Total (n=187)	
	Mean	**SD**	**Mean**	**SD**		**Mean**	**SD**
Age (years)	33.7	8.2	30.2	8.1	0.002**	32.0	8.3
	N	**%**	**N**	**%**		**N**	**%**
Gender							
Male	94	96.9	78	86.7	0.010*	172	92.0
Female	3	3.1	12	13.3		15	8.0
Educational level							
Illiterate	8	8.2	2	2.2	0.267	10	5.3
Elementary/ intermediate	35	36.1	31	34.4		66	35.3
Secondary	26	26.8	24	26.7		50	26.7
University	28	28.9	33	36.7		61	32.6
Occupation							
Unemployed/ Retired	40	41.2	49	54.4	0.019*¶	89	47.6
Employed	28	28.9	16	17.8		44	23.5
Self-employed	29	29.9	20	22.2		49	26.2
Student	0	0.0	4	4.4		4	2.1
Other	0	0.0	1	1.1		1	0.5
Marital status							
Single	65	67.0	68	75.6	0.133	133	71.1
Married	24	24.7	12	13.3		36	19.3
Divorced/ separated	8	8.2	10	11.1		18	9.6
Current housing							
Residence	97	100.0	25	27.8	<0.001*	122	65.2
Rehabilitation	0	0.0	65	72.2		65	34.8
People with whom the participant Stays: pre-treatment (rehabilitation) and currently (OST)							
Alone	7	7.2	4	4.4	<0.001*	11	5.9
Spouse/partner	27	27.8	2	2.2		29	15.5
Parents	61	62.9	14	15.6		75	40.1
Relative/colleagues	2	2.1	66	73.3		68	36.4
No response	0	0.0	4	4.4		4	2.1
Medications Used							
Antidepressants	17	17.5	31	34.4	0.008*¶	48	25.7
Antipsychotic	31	32.0	41	45.6	0.056	72	38.5
Epilepsy-bipolar	11	11.3	31	34.4	<0.001*	42	22.5

*OST, Opioid substitution treatment. *, $p<0.05$ using Independent-Samples T-Test; **, $p<0.05$ using Mann-Whitney U Test. ¶, No significant difference between the OST and rehabilitation groups when females were excluded from the sample*

As evident in Table 2, as part of their history of drug use, 49.7% of the participants used and injected drugs simultaneously and 79.7% of them used drugs more than 3 times daily. There was a significant difference between the treatment modalities and both of these practices were more common among PWUD treated by OST ($p<0.05$). Finally, 77.0% of the participants were addicted only to drugs, while 16.0% had alcohol drinking problems also, which was significantly more common in the rehabilitation group (OST: 1.0%; rehabilitation: 32.2%; $p<0.05$).

Nutritional status, weight gain and anthropometric measurements

The vast majority of the participants (88.8%) were well nourished based on the SGA, and only 11.2% of them fell in the moderately malnourished category.

Two-thirds (66.8%) of the participants reported weight gain during treatment. This finding was more common in the rehabilitation group (OST: 54.6%; rehabilitation: 80.0%; $p<0.05$). On the other hand, 20.0% of the sample reported weight loss. This was more common in the OST group (OST: 32.0%; rehabilitation: 8.9%; $p<0.05$). On average, the BMI of the participants increased from 24.9±4.8 kg/m^2 pre-treatment to 27.0±4.9 kg/m^2 during treatment. Other anthropometric measurements are detailed in Table 3.

Table 2: History of drug use of the participants (n=187)

	OST (n=97)		Rehabilitation (n=90)		p-value	Total (n=187)	
	N	**%**	**N**	**%**		**N**	**%**
Type of drug previously used							
Drug use only	34	35.1	57	63.3	<0.001*	91	48.7
Drug injection only	1	1.0	1	1.1		2	1.1
Drug use and injection	62	63.9	31	34.4		93	49.7
No response	0	0.0	1	1.1		1	0.5
Frequency of drug previously used or injected							
Up to 3 times daily	85	87.6	64	71.1	0.034*	149	79.7
Once or more daily	9	9.3	17	18.9		26	13.9
Once or more weekly	3	3.1	6	6.7		9	4.8
Does not know or remember	0	0.0	1	1.1		1	0.5
No response	0	0.0	2	2.2		2	1.1
Previous treatment							
None	37	38.1	49	54.4	<0.001*	86	46.0
OST	6	6.2	6	6.7		12	6.4
Rehabilitation	22	22.7	28	31.1		50	26.7
Rehabilitation and OST	10	10.3	4	4.4		14	7.5
Hospital detoxification	18	18.6	2	2.2		20	10.7
Hospital detoxification and rehabilitation	4	4.1	0	0.0		4	2.1
No response	0	0.0	1	1.1		1	0.5
Other addiction							
None	90	92.8	54	60.0	<0.001*	144	77.0
Alcohol	1	1.0	29	32.2		30	16.0
Other	6	6.2	7	7.8		13	7.0
	Mean	**SD**	**Mean**	**SD**		**Mean**	**SD**
Duration of drug use (years)	11.4	7.2	10.9	7.3	0.632	11.2	7.2
Duration of drug injection (years) (among those who reported drug injection)	7.3	6.3	8.0	5.6	0.469	7.5	6.1
Age at first drug use and/or injection (years)	18.3	6.7	16.3	4.6	0.006**	17.4	5.9
Number of previous treatment attempts	3.6	4.9	2.0	2.3	0.580	3.1	4.3
Treatment duration (months)	31.0	25.0	5.7	5.3	0.000**	19.2	23.0

OST, Opioid substitution treatment.

**, p<0.05 using Independent-Samples T-Test; **, p<0.05 using Mann-Whitney U Test*

Table 3: Nutritional status, weight change, and anthropometric measurements of the participants (n=187)

	OST (n=97)		Rehabilitation (n=90)		p-value	Total (n= 187)	
	N	**%**	**N**	**%**		**N**	**%**
Subjective Global Assessment (SGA)							
Well nourished	86	88.7	80	88.9	0.960	166	88.8
Moderately malnourished	11	11.3	10	11.1		21	11.2
Weight change							
Weight loss	31	32.0	8	8.9	<0.001*	39	20.9
No change	13	13.4	10	11.1		23	12.3
Weight gain	53	54.6	72	80.0		125	66.8
	Mean	**SD**	**Mean**	**SD**		**Mean**	**SD**
Pre-treatment BMI (kg/m^2)	25.9	4.6	23.0	4.9	0.002**	24.9	4.8
During-treatment BMI (kg/m^2)	26.6	5.2	27.5	4.5	0.189	27.0	4.9
SBP (mmHg)	123.7	13.0	126.5	15.3	0.228	125.0	14.2
DBP (mmHg)	75.7	11.3	79.0	15.9	0.110¶¶	77.3	13.7
Percent body fat (%)	25.0	8.4	26.2	7.3	0.313	25.6	7.9
Waist circumference (cm)	91.0	14.1	93.4	12.2	0.218	92.2	13.2
Neck circumference (cm)	37.4	3.2	37.6	3.4	0.770	37.5	3.3
Male participants							
Percent body fat (%)	24.8	8.4	24.9	6.7	0.935	25.9	7.7
Waist circumference (cm)	91.3	14.0	94.6	12.5	0.024**	92.8	13.4
Female participants							
Percent body fat (%)	31.4	6.5	34.6	4.9	0.356	33.9	5.2
Waist circumference (cm)	81.6	15.3	85.5	6.1	0.705	84.7	8.1

OST, OST: Opioid substitution treatment; BMI, Body mass index; SBP, Systolic blood pressure; DBP, Diastolic blood pressure.
**, p<0.05 using Independent-Samples T-Test; **, p<0.05 using Mann-Whitney U Test*
¶¶, Significant difference between the OST and rehabilitation groups when females were excluded from the sample

Dietary intake

The caloric, macro- and micronutrient intakes reported by the participants are detailed in Table 4. The mean daily energy intake was 32.8±18.3 calories (Kcal) per kg of body weight, and 62.3% of our sample reported consuming more than 25 Kcal per kg of body weight. The average daily intake of proteins was 1.0±0.6 g

per kg of body weight with higher intakes reported by the OST group (OST: 1.1±0.7 g/kg; rehabilitation: 0.9±0.5 g/kg; p<0.05). Further, 41.5% of the participants had intakes below 0.8

grams of proteins per kg body weight; this finding was more noted in the rehabilitation group (OST: 34.4%; rehabilitation: 48.9%; $p<0.05$).

Looking at micronutrients, potassium was the only micronutrient showing a significant difference between the two groups (OST: 2761.9±1584.7 mg; rehabilitation: 2300.2±1150.1 mg; $p<0.05$). This difference was no longer seen when females were excluded.

Table 4: Intake of energy, macro- and micronutrients of the participants (n=187)

	OST (n=97)		**Rehabilitation (n=90)**		**p-value**	**Total (n=187)**	
	Mean	**SD**	**Mean**	**SD**		**Mean**	**SD**
Energy (Kcal)	2728.6	1494.7	2471.2	1013.5	0.173¶¶	2602.0	1283.8
Energy (Kcal/Kg)	34.8	21.1	30.8	14.7	0.140	32.8	18.3
Protein (g)	91.9	52.4	73.2	39.6	0.005*	82.7	47.4
Protein (g/Kg)	1.1	0.7	0.9	0.5	0.006*	1.0	0.6
Added sugar (g)	95.9	94.7	87.2	76.1	0.091	91.6	85.9
Fiber (g)	21.8	13.4	21.2	10.3	0.657	21.5	11.9
Calcium (mg)	816.2	571.4	736.6	425.2	0.815	777.1	505.0
Potassium (mg)	2761.9	1584.7	2300.2	1150.1	0.025*¶	2534.8	1403.5
Iron (mg)	19.4	39.0	14.7	8.1	0.569	17.1	28.4
Zinc (mg)	11.9	9.2	10.2	6.1	0.133	11.1	7.9
Magnesium (mg)	322.0	242.7	278.3	116.2	0.916	300.5	192.0
Selenium (mcg)	118.3	75.6	94.3	54.1	0.028**	106.5	66.8
Thiamin (mg)	1.9	1.1	1.7	0.8	0.125	1.8	0.9
Riboflavin (mg)	1.8	1.3	1.5	0.7	0.197	1.7	1.1
Niacin (mg)	25.7	19.6	19.8	14.9	0.027**	22.8	17.7
Vitamin C (mg)	93.7	98.0	85.1	81.0	0.944	89.5	89.9
Vitamin A (mcg)	826.1	1724.7	431.4	360.0	0.336	632.0	1267.3
Vitamin D (mcg)	1.7	4.6	1.2	1.6	0.406	1.5	3.5
Vitamin E (mg)	10.8	9.6	9.9	5.4	0.619	10.3	7.8
Pyridoxine (mg)	1.6	1.1	1.2	0.7	0.001**	1.4	0.9
Folate (mcg)	355.3	338.3	316.3	240.0	0.731	336.1	293.9
	N	**%**	**N**	**%**		**N**	**%**
Categories of energy intake							
<25 Kcal/kg	36	38.7	33	36	0.776	69	37.7
≥25 Kcal/kg	57	61.3	57	63		114	62.3
Categories of protein intake							
<0.8 g/kg	32	34.4	44	48.9	0.047*	76	41.5
≥0.8 g/kg	61	65.6	46	51.1		107	58.5

*OST, Opioid substitution treatment. *, $p<0.05$ using Independent-Samples T-Test; **, $p<0.05$ using Mann-Whitney U Test. ¶, No significant difference between the OST and rehabilitation groups when females were excluded from the sample. ¶¶, Significant difference between the OST and rehabilitation groups when females were excluded from the sample*

Biochemical parameters

The biochemical profile of the participants is detailed in Table 5. The mean values of HDL and LDL were 43.8±12.3 mg/dl, 115.5±38.9 mg/dl, respectively, with no statistical difference between the treatment groups ($p>0.05$). The mean value of FBS and total serum proteins were 89.7±13.6 mg/dl and 7.3±0.4 g/dl, respectively. Both results were significantly higher in the OST group ($p<0.05$).

Table 5: Biochemical parameters of the participants (n=187)

	OST (n=97)		**Rehabilitation (n=90)**		**p-value**	**Total (n= 187)**	
	Mean	**SD**	**Mean**	**SD**		**Mean**	**SD**
RBC (cells/mcl)	5.2	0.5	5.2	0.4	0.229	5.2	0.4
Hgb (g/dl)	14.7	1.5	15.0	1.2	0.127¶¶	14.8	1.3
Hct (%)	43.6	3.7	44.5	2.9	0.085*	44.0	3.4
WBC (cells/mcl)	8.5	2.5	7.2	2.1	0.001*	7.9	2.4
Platelet (cells/mcl)	259.8	63.5	249.2	66.2	0.291	254.4	64.9
Total Proteins (g/dl)	7.4	0.4	7.3	0.4	0.008*¶	7.3	0.4
Albumin (g/dl)	4.3	0.2	4.2	0.3	0.135	4.3	0.3
FBS (mg/dl)	94.2	16.8	85.4	7.4	<0.001*	89.7	13.6
Total cholesterol (mg/dl)	188.8	53.4	190.9	39.8	0.773	189.9	46.9
LDL (mg/dl)	115.1	44.3	115.9	33.1	0.891	115.5	38.9
HDL (mg/dl)	43.3	12.3	44.3	12.5	0.339	43.8	12.3
Males	43.0	11.8	43.8	12.8	0.554	43.4	12.3
Females	51.0	23.8	47.5	9.7	0.829	48.2	12.5
TG (mg/dl)	118.0	69.2	129.3	147.4	0.527	123.8	115.6
ALT (IU/l)	37.6	50.7	32.3	26.5	0.870	34.9	40.2
AST (IU/l)	32.7	29.7	32.1	25.2	0.924	32.4	27.4

OST, Opioid substitution treatment; RBC, Red blood cells; Hgb, Hemoglobin; Hct, Hematocrit; WBC, White blood cells; FBS, Fasting blood sugar; LDL, Low-density lipoprotein; HDL, High-density lipoprotein; TG, Triglyceride; ALT, Alanine amino transferase; AST, Aspartate amino transferase.

**, p<0.05 using Independent-Samples T-Test; **, p<0.05 using Mann-Whitney U Test*

¶, No significant difference between the OST and rehabilitation groups when females were excluded from the sample

¶¶, Significant difference between the OST and rehabilitation groups when females were excluded from the sample

Lifestyle practices

Table 6 presents the lifestyle practices of the participants. More than three-quarters (75.3%) of our sample had a poor quality of sleep; this was a more common finding in the rehabilitation group (OST: 68.8%; rehabilitation: 82.2%; $p<0.05$). This difference was no longer seen when females were excluded. Further, half of the participants (49.2%) had a low physical activity level that was significantly higher in the OST group (OST:71.1%; rehabilitation: 25.6%; $p<0.05$). Interestingly, around half of the participants (48.9%) were diagnosed with food addiction and more than two-thirds of our sample (69.5%) showed a poor knowledge of nutrition; however, no significant differences were found between the two groups regarding both parameters.

Table 6: Lifestyle practices: sleep, physical activity levels, food dependence, and nutrition knowledge of the participants (n=187)

	OST (n=97)		**Rehabilitation (n=90)**		**p-value**	**Total (n= 187)**	
	N	**%**	**N**	**%**		**N**	**%**
Sleep quality index							
Good sleep quality	30	31.3	16	17	0.033*¶	46	24.7
Poor sleep quality	66	68.8	74	82		140	75.3
Physical activity level							
Low activity level	69	71.1	23	25.6	<0.001*	92	49.2
Moderate activity level	20	20.6	28	31.1		48	25.7
High activity level	8	8.2	39	43.3		47	25.1
Food addiction							
No diagnosis met	53	54.6	40	47.1	0.307	93	51.1
Diagnosis met	44	45.4	45	52.9		89	48.9
Nutrition knowledge							
Poor nutrition knowledge	71	73.2	59	65.6	0.257	130	69.5
Good nutrition knowledge	26	26.8	31	34.4		57	30.5

OST, Opioid substitution treatment.

**, $p<0.05$ using Independent-Samples T-Test; **, $p<0.05$ using Mann-Whitney U Test*

¶, No significant difference between the OST and rehabilitation groups when females were excluded from the sample

Discussion

To date, the nutritional parameters and lifestyle practices of PWUD undergoing treatment for recovery have received little attention in the scientific literature. Up to our knowledge, this study was the first to assess these variables among PWUD undergoing treatment for recovery in Lebanon and the Middle East region. Examining these parameters in the region is important since PWUD,

undergoing treatment in rehabilitation centers in Lebanon, reported excessive food intake as a diversion from the frustration imposed by the strict environment and lack of leisure activities in treatment centers. Furthermore, physical activity was a mandatory routine that was not enjoyed [38]. Besides, reports on drug use in the region do not tackle any of the lifestyle or nutritional parameters covered in this study [23,24]. Accordingly, this study pioneered in exploring major significant differences in the nutritional parameters and lifestyle practices across treatment modalities, namely OST and rehabilitation. Our sample mainly consisted of male participants with early drug use initiation and high frequency of pre-treatment drug use. They are currently exhibiting polymedication as part of their treatment. Our results showed that PUWD undergoing treatment for recovery are subject to numerous vulnerability factors, namely excessive weight gain, poor nutrition knowledge, high food addiction level, in addition to poor sleep quality, and low physical activity level.

First, our findings pinpoint overnutrition in this population group. The vast majority of the participants in both treatment modalities showed good nutritional status, as assessed by the SGA. Further, around 67% of this population, specifically those undergoing rehabilitation, gained weight during treatment. Most importantly, the mean BMI of the group increased to reach the overweight category, and the adiposity in both genders was above the recommended range. Our results provide further evidence regarding the weight gain and increase in BMI seen among PWUD in the months following entry into treatment. This was specifically among PWUD undergoing MMT[6, 7, 10, 39, 40] and residential rehabilitation program[41-43]. The increase in weight, which was more common in the rehabilitation group, could be also attributed to the structured meals offered in the inpatient residential centers, the cravings for sweets as a replacement for drugs, and the excessive eating as a diversion from the frustration of the strict environment imposed [38,44]. Furthermore, this weight gain was perceived as a sign of health to compensate the weight lost during addiction [38]. Excessive weight gain promotes risk for a variety of health outcomes and remains of a potential clinical and medical significance. Additionally, body dissatisfaction, usually arising from overweight, may be a trigger relapse, especially among females who use drugs[10, 44, 45]. This increase in weight, high adiposity and overnutrition comes in parallel with the high reported energy intake among the participants undergoing both treatment modalities. The short duration of treatment among our participants, mainly in the rehabilitation group, may explain this weight gain observed. Available studies confirm increased weight gain and binge eating during the early phase of treatment, as

opposed to a more structured pattern in the latter phase, which typically occurs six months post-treatment entry[41, 44]. Regardless of the precise mechanism involved in the weight gain among this population group, identifying predictors of weight gain would be extremely helpful allowing for preventive measures to be adopted during treatment.

Interestingly, the mean BMI for the participants increased from the normal category prior to treatment (18.0- 24.9 kg/m^2) to the overweight category during treatment (25.0-29.9 kg/m^2). This is coherent with the findings of Fenn et al.[46], but stands in contrast to prior suggestions that weight increase during treatment may be due to a malnourished state moving towards a healthier weight[47, 48]. Documented longitudinal assessment of weight gain and adiposity pre- and during treatment is needed to better understand this issue.

To assess the participants' nutritional status, anthropometric indices alone are not the best indicator. This population group displays hidden deficiencies and disturbed metabolic parameters that need to be deeply investigated by biochemical data, nutrition focused-physical findings, in addition to food addiction[44, 49]. Furthermore, validated tools to assess the nutritional status of this population group need to be developed.

Besides, our study revealed poor nutrition knowledge and a high rate of food addiction among the majority of our participants. These two parameters have not been largely studied among PWUD undergoing treatment for recovery. Similarly, subjects undergoing MMT who scored low on knowledge about healthy diet, showed a higher preference for caloric-dense foods and had a higher BMI[39]. In contrast to our results, Sason et al.[8] reported good knowledge of basic nutrition by all of the participants undergoing MMT. Furthermore, 10% of their patients were diagnosed with food addiction. A reason behind the latter finding could be attributed to the exclusion of participants with a BMI<26 kg/m^2 and those with good nutrition knowledge in that study. Emerging research shows conflicting results correlating food addiction and weight gain among overweight and obese individuals in the general population. Some studies show a positive relation, while others show none[50-53]. It has been suggested that an addiction to food could act in a similar way to other substance addictions. Repeated exposures to pleasurable food would diminish the dopamine brain response[54, 55]. This would lead to larger quantities of food consumed in order to feel satisfied, subsequently perpetuating overeating[56]. Based on this, the high rate of participants diagnosed with food addiction in our study could potentially explain the weight gain reported.

The weight gain seen among patients undergoing treatment from drug use may not be solely due to changes in eating behaviors. Pharmacological treatments received by the participants or the maintenance treatment with the partial opioid agonist may have a significant effect. Weight gain is a frequently observed side effect with many antipsychotic treatments and seems to be underreported and underrecognized in many patients[57, 58]. Interestingly, our study supports this finding, where the highest percent of weight gain seen in the rehabilitation centers could be attributed to the high intake of antipsychotic drugs taken by the participants.

Notably, there was a significant difference in weight gain pattern between the two treatment modalities. Rehabilitation participants showed a much greater weight gain and increase in BMI that was present in around 80% of the subjects. Mysels et al.[59] did not detect a statistical significant course of weight gain between methadone and naltrexone maintenance treatment.

Despite the fact that the majority of the studies in this population group focusses on weight gain, there was a considerable variety in weight changes seen among our participants. Around one-third of the participants experienced either weight loss (21%) or no weight change (12%). This finding was more apparent among the OST participants and could be attributed to the limited economic resources and the financial burdens of family support [60]. The patterns, determinants, outcomes of nutritional status, weight gain or loss in the population of PWUD undergoing treatment for recovery, and the differences noted between OST and rehabilitation need to be explored by future studies. This will inform the development of targeted prevention and intervention programs to improve PWUD's nutritional health and wellbeing along the recovery process.

Regarding macro- and micronutrient intake of our population, the majority of the participants had high energy and protein intakes potentially justifying the increase in weight reported. This is consistent with other studies that showed an increase in the overall intake of energy and proteins after initiation of the treatment[12, 61]. Interestingly, the majority of the vitamins and minerals were within the recommended levels of intake. This can be explained by the structured healthy meals offered in the rehabilitation centers as described by some of the participants in our qualitative research with this population group [38]. On the other hand, our results come in contrast to other studies indicating low levels of micronutrients in different treatment modalities. Their finding was mainly attributed to the increased intakes of energy-dense foods, rather than nutrient-dense ones[11, 12, 59]. Nevertheless, assessing the nutritional status of PWUD only by anthropometric

measurements and dietary intake may not reveal severe malnutrition, as hidden deficiencies might exist and can only be detected through measuring plasma nutrients[2, 44].

To date, few studies have investigated selected biochemical indices in this patient-population, and up to our knowledge no studies on biochemical indices were done specifically on PWUD in rehabilitation centers. Our participants had, on average, normal values of lipid profile during treatment which is coherent with the available studies in PWUD undergoing OST[6,13]. Additionally, FBS, total proteins, and WBC were in the normal category. In contrast to other findings in PWUD undergoing detoxification, our participants showed normal levels of hemoglobin and albumin[62]. This could be attributed to the high micronutrient intakes observed by our participants as opposed to the low intake of nutrient dense foods reported elsewhere[63]. Furthermore, while FBS was within the normal range, it is important to note that it was significantly higher in the OST group. This finding can be supported by the fact that chronic administration of opiate agonists can cause insulin resistance, abnormalities in glucose metabolism, in addition to a higher risk of developing diabetes[64, 65]. This, again highlights the need for further comparison studies between the two treatment modalities. Additionally, longitudinal studies examining the changes of these biochemical indices throughout the treatment and their implications on disease development are needed.

Looking at lifestyle practices, our population exhibited an overall poor quality of sleep. This was more accentuated among the participants undergoing rehabilitation. The sleep of PWUD undergoing treatment for recovery, especially in rehabilitation services, was rarely investigated by the scientific literature. It can be hypothesized that the poor quality of sleep observed among the participants in rehabilitation could be attributed to the drug withdrawal symptoms [18]. Most of the literature confirms poor sleep quality among patients in MMT[15, 16, 66]. Sleep disturbances could be attributed to the comorbid conditions present among this population like psychopathology, alcohol and nicotine abuse, in addition to methadone itself[14, 16]. Generally, sleep is an important aspect in the health-related quality of life of people undergoing treatment from drug use. It may lead to poor treatment adherence, opiate relapse, and the risk of sedative abuse[14, 15, 67]. Furthermore, studies confirm a positive association between short sleep duration and weight gain among healthy adults[68, 69]. Relating poor quality of sleep to weight gain reported and investigating its outcomes among this population group should be further investigated.

Finally, half of the participants in our sample, mainly in the OST group, had a low physical activity level. This significant difference among the two groups could be attributed to the mandatory daily exercise offered in rehabilitation centers as part of the daily routines. Data from our qualitative work on this population group in rehabilitation centers showed contradictory perceptions regarding the mandatory physical activity programs offered [38]. Some reported that it improved their physical and psychological wellbeing and decreased their drug cravings, while others described it as a boring routine that needs to be personalized. Physical activity was shown to reduce sufferings from withdrawals, anxiety, depression, in addition to improving self-confidence[4, 20]. Furthermore, Brown et al.[70] showed that physical activity, as an adjunct to the treatment in this population group, resulted in increasing days of abstinence from drug and alcohol use. However, recommendations on the type and duration of the physical activity to promote these benefits need further exploration due to the paucity of studies in the literature. Additionally, the possible correlation between low physical activity level and weight gain seen in this group needs to be further studied.

Strengths and limitations

Our study presents numerous strengths. First, it pioneers in providing insights into the nutritional parameters and lifestyle practices among a vulnerable population, namely PWUD undergoing treatment for recovery. This was the first study to explore these issues in participants from the Middle East region, specifically Lebanon, where several factors promote drug use including the decades of internal and regional armed conflicts[71,72]. Second, this study highlights a gap in the literature regarding the need for comparison studies between the different treatment modalities offered. Third, we used an exhaustive sample, where all treatment centers were approached. And, in those who granted us permission of entry, all individuals receiving the treatment were approached for participation. Fourth, data collection was conducted by licensed dietitians, nurses and phlebotomists using calibrated instruments. Furthermore, biochemical parameters were analyzed in a laboratory certified by the Ministry of Public health in Lebanon. Additionally, we used validated assessment tools such as SGA[27, 28]; CoNKQ[32]; YFAS[33]; PSQI[34]; IPAQ[35], although further validation among PWUD is required. Finally, this paper paves the way to further studies assessing the nutritional status and intake to identify the predictors of weight gain of PWUD undergoing treatment for recovery. Additionally, it highlights the need for an in-depth

assessment of lifestyle factors among this population group, resulting in a more comprehensive intervention within treatment centers to promote recovery.

In contrast, the present study had some limitations. First, female participants were less represented in our sample. A major reason for this, as mentioned above, was the limited number of residential centers for females in Lebanon, and the fear of stigma among females receiving OST, which prevented them from participating in this study. Second, the reported pre-treatment weight and BMI were used, and subsequently weight change was reported. As this was a cross-sectional study, participants were only met at the date of data collection. Also, change in usual dietary intake (a component of the SGA) was reported by the participant, and it was not assessed objectively. Similarly, dietary intake was measured once using 24-hour dietary recall which does not estimate the usual food intake and depends on the memory of the participants. We tried to attenuate the recall bias by using the United States Department of Agriculture's MPR[29, 30]. In addition, physical activity and sleep quality were reported, but not measured. Third, given the cross-sectional nature of this study, no baseline data for biochemical and nutritional indices were present to compare our results and evaluate the effect of the treatment on disease development and risk of relapse. Fourth, it is possible that because participants were still actively involved in the rehabilitation services when collecting the data, their responses may have been more socially desirable to avoid offending their host institution. Fifth, there is a limited generalizability of the results, because of the non-random sample due to the restrictions by the centers discussed above. Sixth, the Arabic versions of the translated questionnaires used in the study need to be validated for future use, although translated back and forth by two independent bilingual translators. Furthermore, this study lacks a comparison against an aged matched control group due to the lack of data regarding the variables of interest in the general Lebanese population. Finally, our results should be confirmed by future studies in other countries. This will inform whether our findings are shared features among this patient population or unique characteristics of PWUD treated in Lebanon.

Future Studies

Longitudinal studies are needed to further examine changes in biochemical indices, lifestyle practices, adiposity and weight throughout the recovery process and across treatment modalities, as well as the implications of these issues on treatment outcomes and disease development. Specifically, the patterns, determinants, and outcomes predictors of weight change need to be

investigated to inform preventive measures during treatment. Furthermore, the type and duration of the physical activity to be adopted throughout recovery need further exploration. Finally, although the results obtained by this study provide insights for health promotion intervention to be implemented in drug treatment centers, focusing on the importance of increasing nutrition knowledge and physical activity, improving sleep, and dealing with food addiction need to be further studied. Its effectiveness and cost-effectiveness should also be assessed.

Conclusion

The present study fills a gap in the literature regarding the nutritional parameters and lifestyle practices among PWUD in different treatment modalities. The results obtained provide evidence that PWUD undergoing treatment for recovery have a good nutritional status, but experience suboptimal dietary intake, weight gain, increased adiposity. They also have poor lifestyle practices specifically a poor quality of sleep and low physical activity levels. Further research should be conducted on a more representative sample to examine the correlation between specific nutritional parameters and lifestyle practices with weight gain, disease development, and risk of relapse across different treatment modalities. Additional research is also needed to identify the components of a comprehensive and targeted health promotion intervention to be implemented during treatment to improve PWUD's nutritional health and wellbeing throughout the recovery process. This vulnerable group faces many challenges in maintaining a healthy lifestyle, and health promotion programs are essential to improve the treatment experience and prevent relapse.

Acknowledgement:

We would like to acknowledge the support and the encouragement of the rehabilitation centers and the NGOs offering treatment from drug use in Lebanon that contributed to this study: Jeunesse Anti-Drogues (JCD), Oum el Nour, Nusroto Al Anachid, Saadat Al Samaa Association, Association Justice et Misericorde (AJEM), Soin Infirmiers et Developpement Communautaire (SIDC) and Reset Clinics. Our sincere appreciation goes to all the patients who participated. Furthermore, we would like to thank Ms. Maria Bu Kheir, Ms. Marwa Ghayad, Ms. Amira Halabi, Ms. Nisrine Rizk and Ms. Cynthia Farsoun for their help in the data collection.

This work was supported by the Institut National de Santé Publique, d'Epidémiologie Clinique, et de Toxicologie (INSPECT-LB), Beirut- Lebanon.

N.M was involved in the concept and design of the study, collected, analyzed and interpreted the data and drafted the manuscript. R.R. was involved in the concept and design of the study, contributed to data collection, analysis and interpretation, wrote original content and critically revised the manuscript. N.V was involved in the concept and design of the study, wrote original content and critically revised the manuscript. All authors approved the final version of the manuscript.

There are no conflicts of interest.

References

1. UNOCD (2017). World Drug Report. Vienna: United Nations Office on Drugs and Crime.
2. Jeynes KD & Gibson EL (2017) The importance of nutrition in aiding recovery from substance use disorders: A review. *Drug Alcohol Depend* **179**, 229-239.
3. Degenhardt L & Hall W (2012) Extent of illicit drug use and dependence, and their contribution to the global burden of disease. *Lancet* **379**, 55-70.
4. Gimenez-Meseguer J, Tortosa-Martinez J, de los Remedios Fernandez-Valenciano M (2015) Benefits of Exercise for the Quality of Life of Drug-Dependent Patients. *J Psychoactive Drugs* **47**, 409-416.
5. Cowan JA & Devine CM (2012) Process evaluation of an environmental and educational nutrition intervention in residential drug-treatment facilities. *Public Health Nutr* **15,** 1159-1167.
6. Montazerifar F, Karajibani M, Lashkaripour K (2012) Effect of methadone maintenance therapy on anthropometric indices in opioid dependent patients. *Int J High Risk Behav Addict* **1**,100-103.
7. Novick DM, Richman BL, Friedman JM *et al.* (1993) The medical status of methadone maintenance patients in treatment for 11-18 years. *Drug Alcohol Depend* **33**, 235-245.
8. Sason A, Adelson M, Herzman-Harari S *et al.* (2018) Knowledge about nutrition, eating habits and weight reduction intervention among methadone maintenance treatment patients. *J Subst Abuse Treat* **86**, 52-59.
9. Orsini CA, Ginton G, Shimp KG *et al.* (2014) Food consumption and weight gain after cessation of chronic amphetamine administration. *Appetite* **78**, 76-80.
10. Warren CS, Lindsay AR, White EK *et al.* (2013) Weight-related concerns related to drug use for women in substance abuse treatment: prevalence and relationships with eating pathology. *J Subst Abuse Treat* **44**, 494-501.
11. Kolarzyk E, Chrostek Maj J, Pach D *et al.* (2005) Assessment of daily nutrition ratios of opiate-dependent persons before and after 4 years of methadone maintenance treatment. *Przegl Lek* **62**, 368-372.
12. Varela P, Marcos A, Ripoll S *et al.* (1997) Effects of human immunodeficiency virus infection and detoxification time on anthropometric measurements and dietary intake of male drug addicts. *Am J Clin Nutr* **66**, Suppl., S509-S514.

13. Housova J, Wilczek H, Haluzik MM *et al.* (2005) Adipocyte-derived hormones in heroin addicts: the influence of methadone maintenance treatment. *Physiol Res* **54**, 73-78.

14. Stein MD, Herman DS, Bishop S *et al.* (2004) Sleep disturbances among methadone maintained patients. *J Subst Abuse Treat* **26**, 175-180.

15. Beswick T, Best D, Rees S *et al.* (2003) Major disruptions of sleep during treatment of the opiate withdrawal syndrome: differences between methadone and lofexidine detoxification treatments. *Addict Biol* **8**,49-57.

16. Peles E, Schreiber S, Adelson M (2009) Documented poor sleep among methadone-maintained patients is associated with chronic pain and benzodiazepine abuse, but not with methadone dose. *Eur Neuropsychopharmacol* **19**, 581-588.

17. Gillin JC (1998) Are sleep disturbances risk factors for anxiety, depressive and addictive disorders? *Acta Psychiatr Scand* **98**, 39-43.

18. Schierenbeck T, Riemann D, Berger M *et al.* (2008) Effect of illicit recreational drugs upon sleep: cocaine, ecstasy and marijuana. *Sleep Med Rev* **12**, 381-389.

19. Abrantes A & Blevins C (2019) Exercise in the Context of Substance Use Treatment: Key Issues and Future Directions. *Curr Opin Psychol* **30**, 103-108.

20. Roessler KK (2010) Exercise treatment for drug abuse--a Danish pilot study. *Scand J Public Health* **38**, 664-669.

21. Bardo MT & Compton WM (2015) Does physical activity protect against drug abuse vulnerability? *Drug Alcohol Depend* **153**, 3-13.

22. Gerstein DR & Lewin LS (1990) Treating Drug Problems. *N Engl J Med* **323**, 844-848.

23. Ministry of Public Health, Ministry of Education and Higher Education, Ministry of Interior and Municipalities, Ministry of Justice, and Ministry of Social Affairs (2016) Inter-Ministerial Substance Use Response Strategy for Lebanon 2016-2021. https://rm.coe.int/inter-ministerial-substance-use-response-prevention-treatment-rehabili/168075f740 (accessed October 2020).

24. The Middle East and North Africa Harm Reduction Association (MENAHRA) (2020) Lebanon. https://www.menahra.org/en/lebanon (accessed October 2020).

25. Maehira Y, Chowdhury EI, Reza M *et al.* (2013) Factors associated with relapse into drug use among male and female attendees of a three-month drug detoxification–rehabilitation programme in Dhaka, Bangladesh: a prospective cohort study. *Harm Reduct J* **10**, 1-13.

26. Tran BX, Nguyen LH, Nong VM *et al.* (2016) Behavioral and quality-of-life outcomes in different service models for methadone maintenance treatment in Vietnam. *Harm Reduct J* **13**, 1-9.

27. Hirsch S, de Obaldia N, Petermann M *et al.* (1991) Subjective global assessment of nutritional status: further validation. *Nutrition* **7**, 35-38.

28. Bauer J, Capra S, Ferguson M (2002) Use of the scored Patient-Generated Subjective Global Assessment (PG-SGA) as a nutrition assessment tool in patients with cancer. *Eur J Clin Nutr* **56**, 779-785.

29. Moshfegh AJ, Rhodes DG, Baer DJ *et al.* (2008) The US Department of Agriculture Automated Multiple-Pass Method reduces bias in the collection of energy intakes. *Am J Clin Nutr* **88**, 324-332.

30. Raper N, Perloff B, Ingwersen L *et al.* (2004) An overview of USDA's Dietary Intake Data System. *J Food Compost Anal* **17**,545-555.

31. Pellet P & Shadarevian S (1970) Food Composition Tables for Use in the Middle East. Beirut, Lebanon: American University of Beirut.

32. Dickson-Spillmann M, Siegrist M, Keller C (2011) Development and validation of a short, consumer-oriented nutrition knowledge questionnaire. *Appetite* **56**, 617-620.

33. Gearhardt AN, Corbin WR, Brownell KD (2009) Preliminary validation of the Yale Food Addiction Scale. *Appetite* **52**, 430-436.

34. Buysse DJ, Reynolds CF, Monk TH *et al.* (1989) The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res* **28**, 193-213.

35. Craig CL, Marshall AL, Sjostrom M *et al.* (2003) International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc* **35**, 1381-1395.

36. Haidar SA, de Vries NK, Papandreou D *et al.* (2018) The Freshman Weight Gain Phenomenon: Does It Apply To Lebanese Students? *Open Access Maced J Med Sci* **6**, 2214-2220.

37. World Health Organization (2020) Process of translation and adaptation of instruments. https://www.who.int/substance_abuse/research_tools/translation/en/ (accessed October 2020).

38. Mahboub N, Honein-AbouHaidar G, Rizk R *et al.* People who use drugs in rehabilitation, from chaos to discipline: Advantages and pitfalls: A qualitative Study. *PLOS ONE.* Forthcoming 2021.

39. Peles E, Schreiber S, Sason A *et al.* (2016) Risk factors for weight gain during methadone maintenance treatment. *Subst Abus* **37**, 613-618.

40. Parvaresh N, Sabahi AR, Mazhari S *et al.* (2015) A Study of the Sexual Function, Sleep, and Weight Status of Patients after 6 Months of Methadone Maintenance Treatment. *Addict Health* **7**, 24-29.

41. Cowan J & Devine C (2008) Food, eating, and weight concerns of men in recovery from substance addiction. *Appetite* **50**, 33-42.

42. Emerson MH, Glovsky E, Amaro H *et al.* (2009) Unhealthy weight gain during treatment for alcohol and drug use in four residential programs for Latina and African American women. *Subst Use Misuse* **44**, 1553-1565.

43. Hodgkins CC, Cahill KS, Seraphine AE *et al.* (2004) Adolescent Drug Addiction Treatment and Weight Gain. *J Addict Dis* **23**, 55-65.

44. Mahboub N, Rizk R, Karavetian M *et al.* (2020) Nutritional status and eating habits of people who use drugs and/or are undergoing treatment for recovery: a narrative review. *Nutr Rev,* nuaa095.

45. Gottfredson NC & Sokol RL (2019) Explaining Excessive Weight Gain during Early Recovery from Addiction. *Subst Use Misuse* **54**, 769-778.

46. Fenn JM, Laurent JS, Sigmon SC (2015) Increases in body mass index following initiation of methadone treatment. *J Subst Abuse Treat* **51**, 59-63.

47. Grönbladh L & Öhlund LS (2011) Self-reported differences in side-effects for 110 heroin addicts during opioid addiction and during methadone treatment. *Heroin Addict Relat Clin Probl* **13**, 5-12.

48. Okruhlica L & Slezakova S (2008) Weight gain among the patients in methadone maintenance program as come-back to population norm. *Casopis lekařu českych* **147**, 426-430.

49. Chavez MN & Rigg KK (2020) Nutritional implications of opioid use disorder: A guide for drug treatment providers. *Psychol Addict Behav* **34**, 699-707.

50. Masheb RM, Ruser CB, Min KM *et al.* (2018) Does food addiction contribute to excess weight among clinic patients seeking weight reduction? Examination of the Modified Yale Food Addiction Survey. *Compr Psychiatry* **84**, 1-6.

51. Meule A & Gearhardt AN (2014) Food addiction in the light of DSM-5. *Nutrients* **6**, 3653-3671.

52. Murphy CM, Stojek MK, MacKillop J (2014) Interrelationships among impulsive personality traits, food addiction, and Body Mass Index. *Appetite* **73**, 45-50.

53. Pedram P, Wadden D, Amini P *et al.* (2013) Food addiction: its prevalence and significant association with obesity in the general population. *PLOS ONE* **8**, e74832.

54. Burger KSE (2011) variability in reward responsivity and obesity: Evidence from brain imaging studies. *Curr Drug Abuse Rev **4***, 182-189.

55. Stice E, Figlewicz DP, Gosnell BA *et al.* (2013) The contribution of brain reward circuits to the obesity epidemic. *Neurosci Biobehav Rev* **37**, 2047-2058.

56. Pursey KM, Stanwell P, Gearhardt AN *et al.* (2014) The prevalence of food addiction as assessed by the Yale Food Addiction Scale: a systematic review. *Nutrients* **6**, 4552-4590.

57. Müller DJ, Muglia P, Fortune T *et al.* (2004) Pharmacogenetics of antipsychotic-induced weight gain. *Pharmacol Res* **49**, 309-329.

58. Wetterling T & Müssigbrodt HE (1999) Weight gain: side effect of atypical neuroleptics? *J Clin Psychopharmacol* **19**, 316-321.

59. Mysels DJ, Vosburg SK, Benga I *et al.* (2011) Course of weight change during naltrexone versus methadone maintenance for opioid-dependent patients. *J Opioid Manag* **7**, 47-53.

60. Alves D, Costa AF, Custodio D *et al.* (2011) Housing and employment situation, body mass index and dietary habits of heroin addicts in methadone maintenance treatment. *Heroin Addict Relat Clin Probl* **13**, 11-14.

61. Kolarzyk Emilia S-WA & Chrostek-Maj J (2010) Zinc, copper and magnesium intake in a daily diet in opiate-addicted persons before and after 5 years of methadone treatment. *Probl Hig Epidemiol* **91**, 243-247.

62. Islam SN, Hossain KJ, Ahmed A *et al.* (2002) Nutritional status of drug addicts undergoing detoxification: prevalence of malnutrition and influence of illicit drugs and lifestyle. *Br J Nutr* **88**, 507-513.

63. Saeland M, Haugen M, Eriksen FL *et al.* (2009) Living as a drug addict in Oslo, Norway--a study focusing on nutrition and health. *Public Health Nutr* **12**, 630-636.

64. Maruyama A, Macdonald S, Borycki E *et al.* (2013) Hypertension, chronic obstructive pulmonary disease, diabetes and depression among older methadone maintenance patients in British Columbia. *Drug Alcohol Rev* **32**, 412-418.

65. Vallecillo G, Robles MJ, Torrens M *et al.* (2018) Metabolic syndrome among individuals with heroin use disorders on methadone therapy: Prevalence, characteristics, and related factors. *Subst Abus* **39,** 46-51.

66. Zahari Z, Siong LC, Musa N *et al.* (2016) Report: Demographic profiles and sleep quality among patients on methadone maintenance therapy (MMT) in Malaysia. *Pak J Pharm Sci* **29**, 239-246.

67. Bertz JW, Epstein DH, Reamer D *et al.* (2019) Sleep reductions associated with illicit opioid use and clinic-hour changes during opioid agonist treatment for opioid dependence: Measurement by electronic diary and actigraphy. *J Subst Abuse Treat* **106**, 43-57.

68. Patel SR & Hu FB (2008) Short sleep duration and weight gain: a systematic review. *Obesity* **16**, 643-653.

69. Brook JS, Lee JY, Finch SJ *et al.* (2013) Physical factors, personal characteristics, and substance use: associations with obesity. *Subst Abus* **34**, 273-276.

70. Brown RA, Abrantes AM, Read JP *et al.* (2010) A pilot study of aerobic exercise as an adjunctive treatment for drug dependence. *Ment Health Phys Act* **3**, 27-34.

71. Karam EG, Ghandour LA, Maalouf WE *et al.* (2010). A rapid situation assessment (RSA) study of alcohol and drug use in Lebanon. *J Med Liban* **58**,76-85.

72. Ghandour LA, El Sayed DS, Martins SS (2012). prevalence and patterns of commonly abused psychoactive prescription drugs in a sample of university students from Lebanon: an opportunity for cross-cultural comparisons. *Drug Alcohol Depend* **121**, 110-117.

Chapter 5

Patterns and determinants of weight gain among people who use drugs undergoing treatment for recovery in Lebanon

Nadine Mahboub, Rana Rizk, Cynthia Georges Farsoun, Nanne de Vries

Submitted

Patterns and determinants of weight gain among people who use drugs undergoing treatment for recovery in Lebanon.

Abstract

Background: Substance use disorder compromises the nutritional status and eating behaviors of people who use drugs, often leading to malnutrition. Once referred to treatment, hyperphagia and poor lifestyle practices leading to weight gain are observed.

This study aimed to examine the patterns and extent of weight change, and to explore the determinants of weight gain in a sample of people who use drugs undergoing treatment in Lebanon.

Methods: 172 male participants, undergoing either rehabilitation or OST were included. Multivariate regression analysis was applied to assess the effect of different variables on weight gain while adjusting for potentially confounding variables.

Results: Around two thirds of the participants (65.1%) reportedly gained weight (OST: 51.0%, Rehabilitation: 61.0%; $p<0.05$). The mean weight gain was 5.9 Kg and was mainly reported among participants in the underweight, normal, and overweight pre-treatment category and accentuated in the rehabilitation group (OST: 2 Kg, Rehabilitation: 10.6 Kg). Around half of the participants moved from the normal weight to the overweight and obese BMI categories post-treatment. Weight gain was negatively associated with the number of previous treatment attempts (OR= 0.86; CI: 0.74-0.99), duration of current treatment (OR= 0.98; CI: 0.96-0.99), and pre-treatment BMI (OR= 0.88; CI: 0.80-0.96). Looking at other nutrition and lifestyle practices, neither nutrition knowledge, food addiction, physical activity level, nor sleep quality were associated with weight gain.

Conclusion: Treatment from drug use is associated with meaningful weight gain that might lead to health risk factors. Developing health promotion programs to improve treatment process and prevent relapse is of great importance.

Keywords:

Drug use disorder; drug abuse treatment centers; determinants of weight gain; healthy lifestyle; nutritional status; Lebanon.

Introduction

Substance use disorder (SUD) has long been known to compromise the nutritional status and eating behaviors of people who use drugs (PWUD) [1,2]. The majority of the literature generally points towards undernutrition [2-4] associated with decreased intake, poor dietary behaviors, [5,6] and anthropometrics being below the standard values [2,7-10].

Worldwide, more than a quarter of a billion people are estimated to suffer from SUD requiring treatment [11]. The main treatment modalities providing evidence-based behavioral and pharmaceutical therapy include rehabilitation (detoxification or complete abstinence) and opioid substitution treatment (OST) (medication-assisted program). In-patient residential rehabilitation follows a detoxification program in a hospital. The centers employ firm disciplined daily routines in terms of sleeping hours, meal times, and tasks performed. On the other hand, OST is organized in out-patient centers that provide PWUD with a pharmaceutical opioid agonist (buprenorphine or methadone).

After initiation of treatment, whether rehabilitation or OST, lifestyle and nutritional behaviors start to change. Hyperphagia and binging on sugars and fats as substitutes for drugs, low physical activity, inadequate sleep quality and quantity are observed in both treatment modalities [3,12-15]. Subsequently, a trend of weight gain is detected, that might be attributed to the binge eating [16], compromised neurological mechanisms in the brain leading to food addiction [17-21], and medications used to assist in recovering from SUD [3,22-24]. Weight gain during methadone maintenance treatment (MMT) may be directly related to methadone itself [(9)]. A shift in dietary preferences towards sweet and fatty foods [25], in addition to derangement in glycemic controls is associated with exposure to opiate agonists [26].

Weight gain and poor lifestyle practices have been linked to increased risk of chronic diseases such as diabetes, cardiovascular diseases, and psychological disorders in healthy individuals [27-29]. The association between weight gain and non-communicable diseases among people with SUD has been scarcely studied. Sweeney et al. [30] found that the percentage of patients with cardiovascular risk factors increased with increasing body mass index (BMI) during MMT. Additionally, body dissatisfaction, usually arising from weight gain, is a probable factor for relapse, especially among females [3,31-33].

Although the majority of the literature points towards weight gain during treatment from SUD [12,32,34], little is known about the patterns and extent of weight change in this population group.

Some recovering patients experience further weight loss, while others experience no weight change [35]. In addition, significant differences concerning weight gain have been observed across different treatment modalities [35]. Determinants of weight gain during treatment remain understudied. However, such data are crucial to inform health promotion and weight gain preventive measures during treatment, ultimately improving treatment outcomes and preventing relapse.

Lebanon is a small high-middle income country in the Eastern Mediterranean region. Armed conflicts internally and in the region were prompting factors for an extensive drug use that is higher than the global average [36]. Furthermore, Lebanon is a transit country for illicit drugs trafficking in combination with a high local production [37]. All of these factors lead to the wide availability of illicit drugs, and lack of control over its consumption [38].

This study aims to examine the patterns and extent of weight change in PWUD undergoing treatment for recovery in Lebanon and explore the differences in these variables between people receiving OST and those undergoing rehabilitation. Furthermore, we also aim to explore the determinants of weight gain in this sample.

Methods

This is a cross-sectional study conducted in drug treatment facilities offering OST and institutionalized rehabilitation services post-detoxification in Lebanon. The details of the study are presented in Mahboub et al. [35]. A convenience sample was chosen as only three out of four OST centers, and four out of seven rehabilitation centers accepted to participate. Participants included were Lebanese, adults above 18 years of age and receiving treatment for more than 1 month. 187 subjects met the inclusion criteria and participated in the original study. Due to the small female sample size, only males were included in this study (OST: n=94; rehabilitation: n=78).

All PWUD treated in these centers were informed about the objectives and the methods of the study, in addition to their right to withdraw at any time. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Lebanese International University's Committee on Research Ethics (CRE) (case number: LIUIRB- 180122-NB1). Written informed consent was obtained from all subjects.

Data collection

Data collection was conducted in the treatment centers by trained licensed dietitians between January 2018 and March 2019, and required 40-50 minutes per participant.

Collected data included:

- Demographics, medical history, and history of drug use were explored using a questionnaire. The questions were based on elements found in the literature associated with the nutritional status, eating habits, and lifestyle of PWUD or those undergoing treatment for recovery.
- Anthropometric measurements: trained licensed dietitians assessed the participants for anthropometrics: 1) height (cm) using a portable digital wall mounted height scale measured to the nearest 0.1 cm without shoes; 2) weight (kg) using a calibrated mechanical floor scale without shoes and with light clothes on. BMI was calculated as the ratio of weight (kg) and height squared (m^2). BMI categories were classified as: underweight (<18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25-29.9 kg/m^2), and obese (> 30 kg/m^2) (WHO, 2000).
- Self-reported weight change (kg) were assessed as the difference between reported usual pre-treatment body weight (kg) and measured body weight (kg) at the day of the assessment.
- Dietary intake measurements: assessed by the 24-hour food recall using the United States Department of Agriculture's Multiple Pass Food Recall (MPR), which attenuates the recall bias [39,40]. Daily energy, macronutrient, and micronutrient intake of the participants were computed from the 24-hour recalls using the food composition database of the Nutritionist Pro software (Nutritionist Pro, Axxya Systems, San Bruno, CA, USA, version 5.1.0, 2018). The software from the database was expanded by adding an analysis of locally consumed foods and recipes [41]. Values arising from the analyzed data were compared with the US-based Dietary Reference Intakes (DRIs), as recommended by the Institute of Medicine (Dietary Reference Intake Tables) due to the lack of gender or age-specific DRIs for the Middle Eastern populations
- Nutrition knowledge: measured using the Consumer-Oriented Nutrition Knowledge Questionnaire (CoNKQ) which was adapted from Spillman & Keller [42]. This is a validated questionnaire, with good internal reliability (Cronbach's alpha: 0.743), and construct

validity. It consists of 20 comprehensive questions derived from consumer interviews and expert recommendations about healthy eating. A score of less than 60% is defined as poor knowledge

- Food addiction: assessed using the Yale Food Addiction Scale (YFAS) [43]. This highly reliable scale (Cronbach's alpha: 0.84), is developed to identify food addiction towards certain types of foods (high fat and high sugar) among individuals. Food patterns over the past 12 months are assessed and the criteria of food addiction is translated in relation to eating behaviors like withdrawal symptoms, difficulties cutting down, tolerance, etc.). Food addiction is diagnosed when three or more of the mentioned eating behaviors symptoms are present within the past 12 months.
- Sleep quality: assessed using the Pittsburgh Sleep Quality Index (PSQI) [44]. The questionnaire consists of four questions to estimate the duration of sleep, the time needed to fall asleep, the time needed to wake up, in addition to the duration spent in bed immediately after waking up. Moreover, five other questions were used to identify reasons for troubled sleep. Answers to these questions were converted to a total score whereby a score of 5 or more indicates poor sleep quality, and a score between 0-4.9 indicates good sleep quality.
- Physical activity: assessed using the International Physical Activity Questionnaire (IPAQ). Seven questions measure the duration and frequency of all levels of physical activity (light, moderate, and vigorous) in the past seven days [45].

The Arabic version of the PSQI, culturally adapted by Haidar et al. [46], was used. The other questionnaires used in this study were translated to Arabic and adapted following the recommended process [47].

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) version 24.0 was used for data entry, management and analyses. Continuous data were reported as means and standard deviation (SD), and categorical data were reported as frequencies (N) and percentages. Normality of the data was tested using the Kolmogorov-Smirnov Test. Independent Samples *t* Test was used to compare data for continuous variables with a normal distribution, and Mann-Whitney U Test for variables with a skewed distribution. Chi-square test was used to compare data for categorical variables.

Multivariate regression analysis was applied to assess the effect of different variables on weight gain while adjusting for potentially confounding variables. First, a bivariate analysis was conducted to explore sociodemographic, drug use, treatment-related, nutrition, and lifestyle variables associated with weight gain (reference category: no weight gain). Variables with *P*-values < 0.2 were retained for the regression analysis. Second, a stepwise regression analysis assessed the association between weight gain (yes versus no) and the different determinants. Variables included in the model were: number of previous treatment attempts; duration of current treatment in months; type of treatment (reference: OST); current use of any medication (reference: no); pre-treatment BMI in kg/m^2; food addiction (reference: no diagnosis); nutrition knowledge (reference: good knowledge); sleep quality (reference: good sleep quality); physical activity (reference: high). A *P*-value < 0.05 was used to indicate statistical significance. Odds ratios and 95% confidence intervals were calculated.

Results

Basic demographic information, medical and drug use history of the sample are presented in Table 1. The mean age of the population was 33 years. Around 30% of the participants had a secondary or university level of education, with 44.2% being unemployed at the time of data collection. Use of nervous system drugs was common among the participants. Around half of the participants (52.6%) in rehabilitation treatment had never been previously admitted to recovery, compared with 37.2% in the OST group ($p<0.05$). Furthermore, more than three-quarter of the population (77.3%) were only addicted to drugs, while 15.1% also had alcohol drinking problems, with this problem being more frequent in the rehabilitation group ($p<0.05$). On average, the participants previously attempted treatment nearly 3 times, and were on treatment for around 25 months. Treatment duration was significantly higher in the OST group.

Table 1: Demographics characteristics and drug use history of the participants (n=172)

	OST (n=94)		Rehabilitation (n=78)		p-value	Total (n=172)	
	Mean	**SD**	**Mean**	**SD**		**Mean**	**SD**
Age (years)	33.7	8.3	30.5	8.3	0.007**	33.0	8.6
	N	**%**	**N**	**%**		**N**	**%**
Educational level							
Illiterate	8.0	8.5	2.0	2.6	0.446	10.0	5.8
Elementary/ intermediate	35.0	37.2	31.0	39.7		66.0	38.4
Secondary	26.0	27.7	22.0	28.2		48.0	27.9
University	25.0	26.6	23.0	29.5		48.0	27.9
Occupation							
Unemployed/ Retired	38.0	40.4	38.0	48.7	0.07	76.0	44.2
Employed	27.0	28.7	15.0	19.2		42.0	24.4
Self-employed	29.0	30.9	20.0	25.6		49.0	28.5
Student	0.0	0.0	4.0	5.1		4.0	2.3
Other	0.0	0.0	1.0	1.3		1.0	0.6
Marital status							
Single	63.0	67.0	61.0	78.2	0.221	124.0	72.1
Married	23.0	24.5	11.0	14.1		34.0	19.8
Divorced/ separated	8.0	8.5	6.0	6.4		14.0	8.1
Current housing							
Residence	94.0	100.0	24.0	30.8	<0.001¶	118.0	68.6
Rehabilitation	0.0	0.0	54.0	69.2		54.0	31.4
People with whom the participant stays: pre-treatment (rehabilitation) and currently (OST)							
Alone	7.0	7.4	4.0	5.1	<0.001¶	11.0	6.4
Spouse/partner	26.0	27.7	2.0	2.6		28.0	16.3
Parents	59.0	62.8	13.0	16.7		72.0	41.9
Relative/colleagues	2.0	2.1	56.0	71.8		58.0	33.7
No response	0.0	0.0	3.0	3.8		3.0	1.7
Medications used							
Antidepressants	16.0	17.0	23.0	29.5	0.067	39.0	22.7
Antipsychotic	30.0	31.9	31.0	39.7	0.337	61.0	35.5
Epilepsy-bipolar	11.0	11.7	24.0	30.8	0.002¶	35.0	20.3

	OST (n=94)		Rehabilitation (n=78)		p-value	Total (n=172)	
	N	**%**	**N**	**%**		**N**	**%**
Previous treatment							
None	35.0	37.2	41.0	52.6	0.002¶	76.0	44.2
OST	6.0	6.4	4.0	5.1		10.0	5.8
Rehabilitation	22.0	23.4	27.0	34.6		49.0	28.5
Rehabilitation and OST	10.0	10.6	3.0	3.8		13.0	7.6
Hospital detoxification	17.0	18.1	2.0	2.6		19.0	11.0
Hospital detoxification and rehabilitation	4.0	4.3	0.0	0.0		4.0	2.3
No response	0.0	0.0	1.0	1.3		1.0	0.6
Other addiction							
None	87.0	92.6	46.0	59.0	<0.001¶	133.0	77.3
Alcohol	1.0	1.1	25.0	32.1		26.0	15.1
Other	6.0	6.4	7.0	9.0		13.0	7.6
	Mean	**SD**	**Mean**	**SD**		**Mean**	**SD**
Duration of drug use (years)	11.5	7.2	11.4	7.5	0.782	12.8	7.7
Duration of drug injection (years) (among those who reported drug injection)	7.4	6.3	8.6	5.7	0.352	7.7	6.2
Number of previous treatment attempts	3.7	4.9	2.0	2.4	0.052	3.1	4.4
Treatment duration (months)	31.6	25.6	5.5	5.5	<0.001**	24.9	27.9

OST, Opioid substitution treatment.
**, p<0.05 using Independent-Samples T-Test; **, p<0.05 using Mann-Whitney U Test*
¶, p<0.05 using Chi-Square

Table 2 details the anthropometric and lifestyle practices of the participants. The average BMI of the participants increased from 25.9±5.2 kg/m^2 to 27.4±5.5 kg/m^2. The mean energy intake of the sample was 2641.9 kcal/day with no statistical difference across treatment modalities. Around two thirds of the participants (65.1%) reportedly gained weight; this finding was more common in the

rehabilitation group (OST: 51.0%, Rehabilitation: 61.0%; p<0.05). Three quarters (75.4%) of the participants had poor sleep quality, this result was more frequent in the rehabilitation group. Moreover, around half of the participants (50.6%) had low physical activity levels. This was more common in the OST group. Finally, half of the participants were diagnosed with food addiction, and the majority has poor nutrition knowledge (49.1% and 68.6% respectively).

Table 2: Anthropometrics and lifestyle practices of the participants (n=172)

	OST (n=94)		**Rehabilitation (n=78)**		**p-value**	**Total (n=172)**	
	Mean	**SD**	**Mean**	**SD**		**Mean**	**SD**
Pre-treatment BMI (Kg/m^2)	25.9	4.7	24.1	5.0	0.016*	25.9	5.2
During- treatment BMI (Kg/m^2)	26.6	5.3	27.6	4.6	0.209	27.4	5.5
Energy (Kcal)	2781.8	1485.4	2480.4	892.9	0.548	2641.9	1251.5
Energy (Kcal/Kg)	35.4	21.1	30.0	12.0	0.297	32.9	16.6
	N	**%**	**N**	**%**		**N**	**%**
Weight change							
Weight loss	31.0	33.0	7.0	9.0	<0.001¶	38.0	22.1
No change	12.0	12.8	10.0	12.8		22.0	12.8
Weight gain	51.0	5.8	61.0	78.2		112.0	65.1
Sleep quality index							
Good sleep quality	28.0	30.1	14.0	17.9	0.076	42.0	24.6
Poor sleep quality	65.0	69.9	64.0	82.1		129.0	75.4
Physical activity level							
Low activity level	68.0	72.3	19.0	24.4	<0.001¶	87.0	50.6
Moderate activity level	19.0	20.2	24.0	30.8		43.0	25.0
High activity level	7.0	7.4	35.0	44.9		42.0	24.4
Food addiction							
No diagnosis met	50.0	53.2	36.0	48.0	0.538	86.0	50.9
Diagnosis met	44.0	46.8	39.0	52.0		83.0	49.1
Nutrition knowledge							
Poor nutrition knowledge	69.0	73.4	49.0	62.8	0.142	118.0	68.6
Good nutrition knowledge	25.0	26.6	29.0	37.2		54.0	31.4

OST, Opioid substitution treatment.
**, p<0.05 using Independent-Samples T-Test; **, p<0.05 using Mann-Whitney U Test*
¶, p<0.05 using Chi-Square

Total reported weight change, weight change per pre-treatment BMI categories, and per treatment method are detailed in Table 3. The mean weight gain of the participants was 5.9±12.4 kg (OST: 2.0±11.3 kg, Rehabilitation: 10.6±12.0 kg). Weight gain was reported among participants who

were underweight, normal and overweight pre-treatment. In contrast, participants who were obese pre-treatment in the OST group lost weight during treatment, while those in the rehabilitation group reportedly gained weight.

Table 3: Total weight change (kg), and weight change per pre-treatment BMI categories and treatment method

	OST (n=94)			Rehabilitation (n=78)			Total (n=172)		
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
Underweight	1.0	17.0		9.0	24.5	12.3	10.0	23.8	11.9
Normal	40.0	1.6	5.5	40.0	12.4	10.4	80.0	7.0	9.9
Overweight	40.0	4.8	12.1	17.0	4.2	8.9	57.0	4.6	11.2
Obese	13.0	-6.1	17.3	12.0	3.4	10.5	25.0	-1.56	15.0
Total	94.0	2.0	11.3	78.0	10.6	12.0	172.0	5.9	12.4

BMI, Body mass index; OST, Opioid substitution treatment.

Figure 1a illustrates the trends of weight change during treatment across BMI categories in the total sample. Out of 10 participants in the pre-treatment underweight category 6 (60%) normalized their weight, whereas 3 (30%) became overweight. Furthermore, 32 participants out of 80 (40%) who had normal pre-treatment weight moved to the overweight and obese categories, whereas 31.6% of the overweight participants became obese. On the contrary, around 28% of the initially obese participants moved to the overweight and normal BMI categories during treatment.

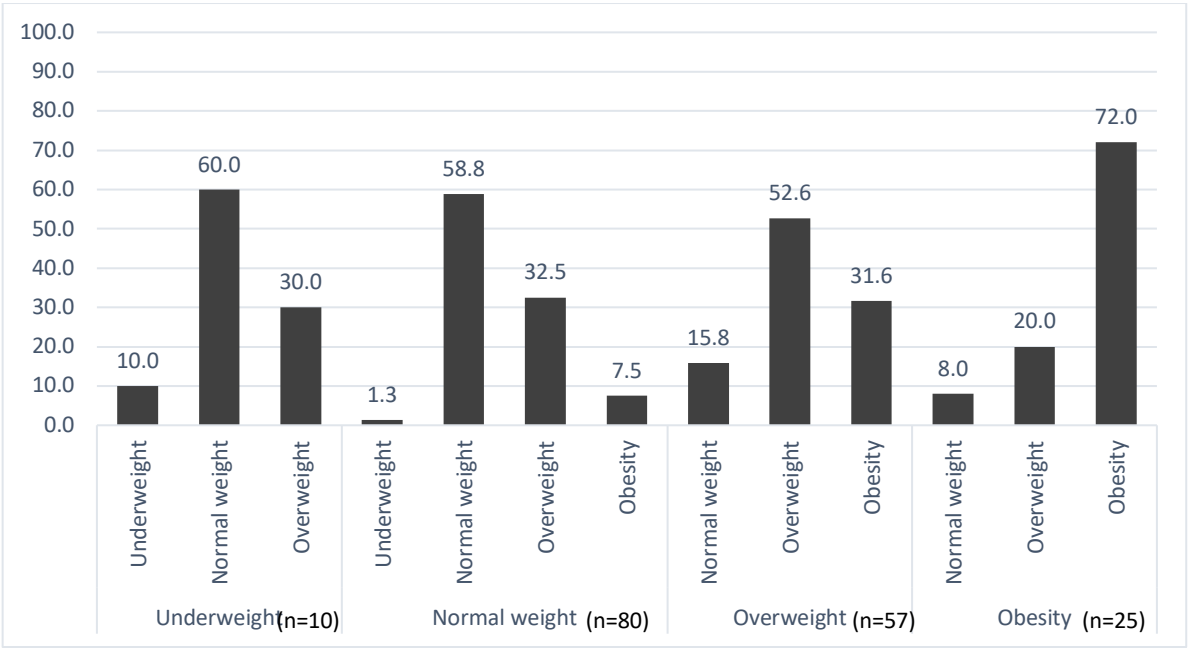

Figure 1a: BMI changes pre- and during treatment (n=187)
Pre-treatment BMI (Horizontal), post-treatment BMI (Vertical). Values are presented as percentages

Percentages of participants changing BMI category post-treatment are illustrated in Figures 1b and 1c. The weight gain trend was more accentuated in the rehabilitation group compared with the OST group. Three participants out of 9 in the underweight category became overweight (33.3%). Moreover, the majority of the participants; 26 out of 40 (65%) within the normal weight BMI category in the rehabilitation group moved to the overweight and obese category post treatment, as opposed to 6 out of 40 participants (15%) in the OST group. Furthermore, 35.3% and 30% of the participants in the overweight BMI category from rehabilitation and OST groups respectively became obese. Finally, 30.8% and 25% of the obese participant in OST and rehabilitation respectively moved to the overweight and normal weight BMI categories.

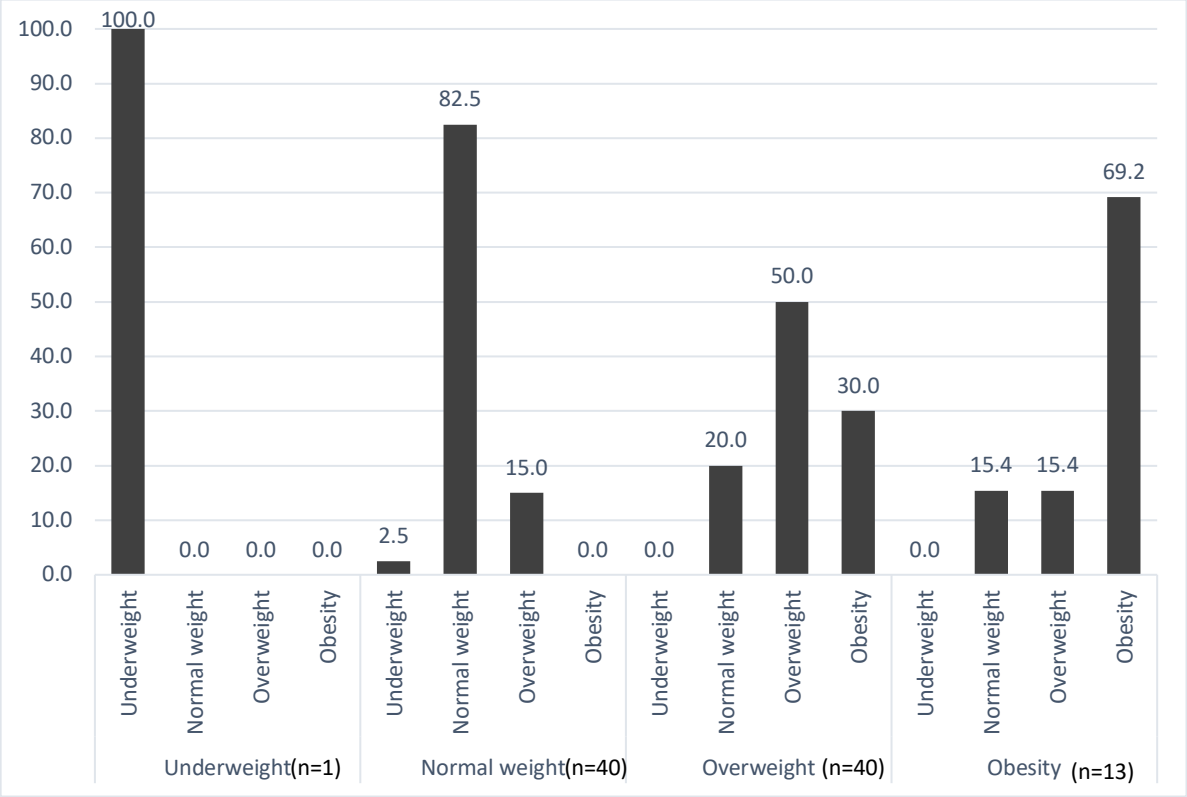

Figure 1b: BMI changes pre- and during OST (n=97)
Pre-treatment BMI (Horizontal), post-treatment BMI (Vertical). Values are presented as percentages

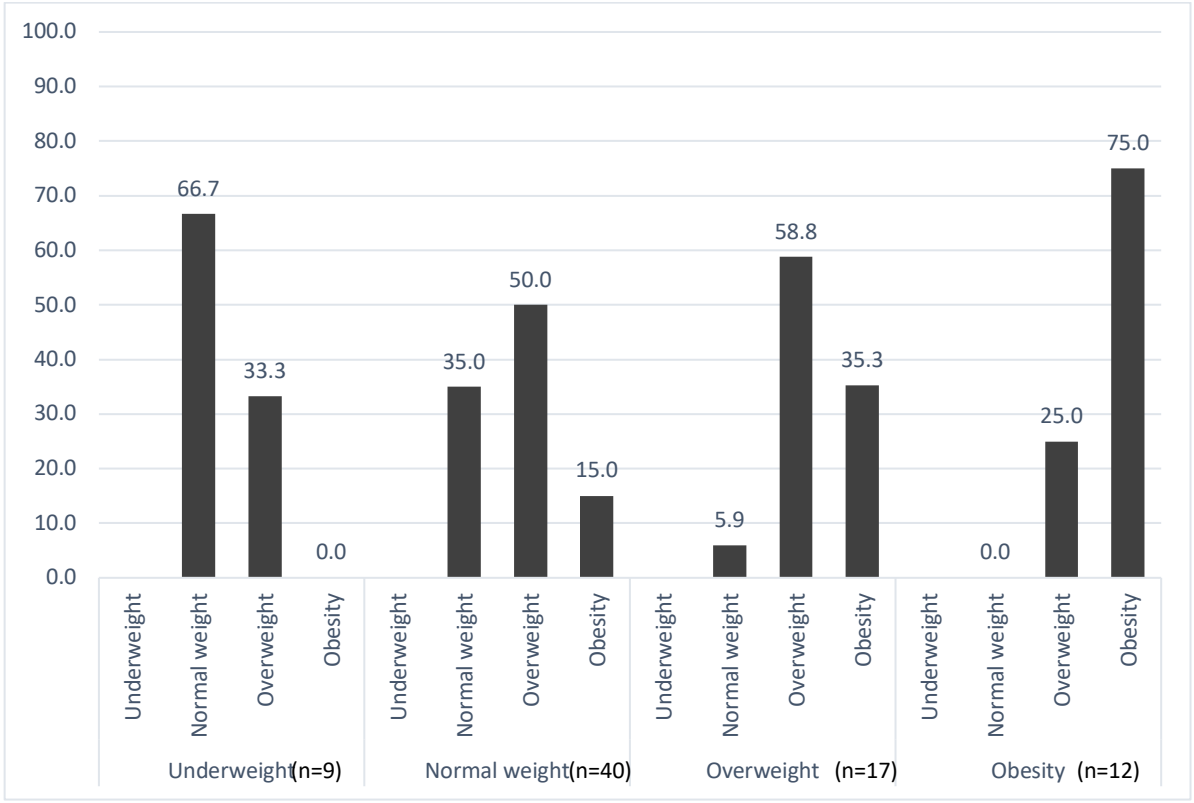

Figure 1c: BMI changes pre- and during rehabilitation (n=90)
Pre-treatment BMI (Horizontal), post-treatment BMI (Vertical). Values are presented as percentages

The bivariate associations between sociodemographic, drug use and treatment method, nutrition and lifestyle practices, and weight gain are illustrated in Table 4. The number of treatment attempts and duration of current treatment were significantly lower among participants who reported weight gain. Furthermore, more participants reporting weight gain were in rehabilitation treatment compared with OST and were currently using medications. Finally, pre-treatment BMI was significantly associated with weight gain in the studied sample. No significant associations were observed with other lifestyle practices.

Table 4: Bivariate analysis of demographics, drug use, treatment methods, anthropometrics, nutrition and lifestyle practices with weigh gain (n=172)

	No weight gain (n=60)		Weight gain (n=112)		p-value
	Mean	**SD**	**Mean**	**SD**	
Age in years	33.2	8.1	31.8	8.5	0.309
Duration of drug use (years)	12.5	8.3	10.9	6.6	0.197
Number of previous treatment attempts	2.6	5.0	0.9	1.8	0.022*
Duration of current treatment (months)	25.5	27.4	16.6	20.1	0.030*
Energy (Kcal/Kg)	36.0	20.3	31.3	16.0	0.108
Protein (g/Kg)	1.1	0.6	1.0	0.6	0.220
Fiber (g)	21.9	13.1	22.4	11.3	0.772
	% from total calories	**SD**	**% from total calories**	**SD**	
Carbohydrate	48.6	9.7	49.6	10.4	0.578
Added sugar	2.8	4.0	2.5	3.3	0.673
Fat	38.7	9.4	38.1	10.1	0.693
	N	**%**	**N**	**%**	
Educational level					
Illiterate	2.0	3.3	8.0	7.1	0.735
Elementary/intermediate	23.0	38.3	43.0	38.4	
Secondary	16.0	26.7	32.0	28.6	
University	19.0	31.7	29.0	25.9	
Type of treatment					
OST	43.0	71.7	51.0	45.5	0.001*
Rehabilitation	17.0	28.3	61.0	54.5	
Current use of antidepressants	11.0	18.3	28.0	25.0	0.347
Current use of antipsychotics	16.0	26.7	45.0	40.2	0.095
Current use of epilepsy/bipolar medications	10.0	16.7	25.0	22.3	0.432
Current use of any medications	24.0	40.0	58.0	51.8	0.152
Pre-treatment BMI (kg/m2)					
Underweight (%)	0.0	0.0	10.0	8.9	0.003*
Normal weight (%)	22.0	36.7	58.0	51.8	
Overweight (%)	24.0	40.0	33.0	29.5	
Obesity (%)	14.0	23.3	11.0	9.8	
Food addiction					
No diagnosis met	30.0	52.6	56.0	50.0	0.871
Diagnosis met	27.0	47.4	56.0	50.0	
Nutrition knowledge					
Poor knowledge	40.0	66.7	78.0	69.6	0.732
Good knowledge	20.0	33.3	34.0	30.4	
Sleep quality index					
Good sleep quality	18.0	30.0	24.0	21.6	0.265
Poor sleep quality	42.0	70.0	87.0	78.4	
Physical activity level					
Low	33.0	55.0	54.0	48.2	0.408
Moderate	16.0	26.7	27.0	24.1	
High	11.0	18.3	31.0	27.7	

*OST, Opioid substitution treatment; BMI, Body mass index. * $p<0.05$*

Determinants of weight gain are detailed in Tables 5. Weight gain was negatively associated with the number of previous treatment attempts (OR= 0.86; CI: 0.74-0.99), duration of current treatment (OR= 0.98; CI: 0.96-0.99) and pre-treatment BMI (OR= 0.86; CI: 0.79-0.95).

Table 5: Multivariate logistic regression of determinants of weight gain

	Weight gain (reference: no)			
	OR	**95% C.I.**		**P-value**
		Lower	**Upper**	
Number of previous treatments	0.86	0.74	0.99	0.043
Duration of current treatment (months)	0.98	0.96	0.99	0.015
Pre-treatment BMI(Kg/m^2)	0.86	0.79	0.95	0.003

*Variables included in the model were: number of previous treatment attempts; duration of current treatment (months); Energy (Kcal/Kg***);** *type of treatment (reference: OST); current use of any medication (reference: no); pre-treatment BMI (kg/m^2); food addiction (reference: no diagnosis met); nutrition knowledge (reference: good knowledge); sleep quality (reference: good sleep quality); physical activity (reference: high).*
OR: odds ratio; CI: confidence interval; OST, Opioid substitution treatment; BMI, Body index
** p<0.05*

Discussion

The Middle East and North Africa (MENA) region is home to the world's largest producer of opioids, as well as to major drug trade routes [48]. Subsequently, the region faces a large drug use problem due to the increased availability of inexpensive heroin [49]. Looking at Lebanon, a part of the MENA region, drug abuse has progressed in the country following the civil war due to the easy access of drugs, socioeconomic crises, and fragility of the population after the armed conflicts [36]. At the same time, Lebanon hosts World Health Organization (WHO)-designed knowledge hubs related to PWUD for the region [37]. Studies examining the nutritional status and lifestyle practices of PWUD undergoing treatment for recovery in the MENA region, specifically Lebanon, are scarce. Mahboub et al. [35] reported excessive weight gain in addition to poor nutrition knowledge, high food addiction level, poor sleep quality, and low physical activity level among PWUD in different treatment centers in Lebanon. To our knowledge, the patterns of weight change and studying the determinants of weight gain in PWUD undergoing different treatment modalities are not addressed in the literature. Such studies are of great importance for the development of health intervention programs aiming at improving health status and preventing relapse among this population group.

Accordingly, this paper pioneers in investigating weight change patterns and determinants of weight gain among PWUD in treatment centers in Lebanon. Our sample consisted of 172 male participants undergoing either rehabilitation or OST. The main findings reflect that weight gain was significantly higher in the rehabilitation group, among people with fewer treatment attempts, and people who were either underweight, normal and overweight pre-treatment. Further future studies in Lebanon and in the region are warranted for comparability and generalizability of the results among all PWUD undergoing treatment for recovery.

Our results in general show high energy intake and weight gain among the participants in both treatment modalities. This finding is supported by many studies showing weight gain and increase in BMI among PWUD undergoing methadone maintenance treatment (MMT) [32,50,51] and residential rehabilitation [13,52]. This increase in weight may be related to engaging in atypical eating habits where patients replace their obsession with drugs with that of sweet taste seeking common euphoric rewards [3,53], impulsive unhealthy eating patterns following drug cessation leading to increased energy intake [54], and the impact of the psychotropic medications prescribed [3,26,55]. Several studies have also reported that individuals in MMT experience increased consumption of sweet and other palatable foods leading to higher energy intakes, thus weight gain and higher BMIs [(24; 53)]. Consumptions of sugars has shown to elevate endogenous opiates which is an underlying motivational reward mechanism in the brain [56]. This suggests that there may be treatment-related factors influencing BMI changes and weight gain [(53)]. The link between drugs and food merits further investigation as it is still unclear whether taste preference is due to the use of drugs or vice versa [(24)]. Furthermore, looking at weight changes across different pre-treatment BMI categories and treatment modalities, the majority of the participants who were in the underweight, normal and overweight category mainly gained weight during treatment and moved to a higher BMI category in both treatment modalities. This shift in the BMI was more predominant in the rehabilitation group. Finally, the majority of the participants who were initially obese maintained their status. In support to our findings, Peles et al. [51] and Sweeney et al. [25] reported an increase in the number of patients categorized as overweight or obese, and a decrease in the number of patients categorized as normal weight, nine months post admission to MMT. Moreover, Montazerifar et al. [50] showed that the percentage of patients in MMT who were initially categorized as being overweight or obese remained as such after eight weeks of treatment. In another study, the percentage of adolescents in residential rehabilitation treatment centers who are at risk of being

overweight (BMI between 85-95% for gender and age) increased from 7.1% to 14.7 % after three months of the treatment [57]. Treatment for drug use disorder is lifesaving but is associated with prevalence of weight gain. Identifying protective factors to decrease the negative clinical risk factors is warranted.

It is worth noting that the majority of observed weight gain and BMI increases among our sample was not a function of undernourished drug users moving towards a healthier weight. Evidence suggests that unhealthy weight gain in this population is an overlooked problem. Obesity and overweight are common among the general population, and are risk factors for several diseases like hypertension, diabetes, and cardiovascular disorders [58]. Alarmingly, the increment in weight gain overtime among MMT patients has been reported to be comparable with that of the general population [51]. After three years of MMT, the percentage of patients being obese or morbidly obese was higher than the percentage of adults in the United States whose weight were categorized as such [25]. Furthermore, the increase in BMI among adolescents in rehabilitation centers was above the expected 10% for a gender and aged matched population [57]. The trend of overweight and obesity prevalence among PWUD in treatment for recovery is alarming due to its potential negative health outcomes. There is evidence of an increased prevalence of type 2 diabetes, hypertension, and hyperlipidemia among PWUD undergoing MMT [25,59,60]. This reported increase exceeds the general population estimates. However, prospective long-term studies examining hard outcomes in this population are scarce. Longitudinal studies examining weigh change patterns, characterizing the risk factors linked to weight gain, and looking at the implications of this weight gain on health at different treatment intervals are warranted.

Participants with higher pre-treatment BMI experienced less weight gain during treatment. Similar to our results, Peles et al. [51] reported that the BMI of patients categorized as initially high (BMI $\geq$27 Kg/m^2) in MMT did not change significantly overtime in treatment. Furthermore, studies on normal populations reported that thin individuals can gain weight more easily than obese individuals [61]. Future studies on the association of pre- treatment BMI among PWUD in recovery are warranted for generalization of results.

In our study, participants in rehabilitation had a more significant weight gain than people receiving OST. To our knowledge no studies in the literature compared the two types of treatments in terms of weight gain. A possible explanation is that OST is an unsupervised program where participants return home after receiving their dose of treatment, hence they might not be fully complying to

abstinence of drugs leading to decreased food consumption and irregular eating patterns [4]. Furthermore, our unpublished data on PWUD undergoing OST in Lebanon revealed that the majority of the participants experienced dysfunctional family relationships, criminal justice involvement and insufficient income, all of which make eating healthy a challenge and exacerbates food insecurity. On the other hand, residential treatment centers are strictly supervised so that complete abstinence of drugs is secured. Participants follow a disciplined routine having three communal meals at fixed times and a structured physical activity program [13] Mahboub et al., [33]. Given this, one would assume that this might be ideal to get people in shape, but binging on sugary and high fat foods as a compensation for the drug and out of boredom from the strict environment has been observed [33,62]. Another explanation to this higher weight gain is the highly processed foods offered instead of healthy options due to limited financial resources of these institutions [33,53]. Finally, weight gain is perceived by underweight participants as a healthy indicator that was targeted and well received in the early phases of the treatment [32,33]. In spite of this significant difference in weight gain across treatment modalities, in the multivariate analysis the type of treatment did not show to be an independent determinant of weight gain among this population group. This could be attributed to the small sample size in each group. Future studies are warranted to further investigate whether there is a need to tailor different intervention programs addressing all risk factors associated with weight gain, based on the type of treatment offered. Rehabilitation centers provide a stable environment to target health risk behaviors among a homogenous population with common features and support system. On the other hand, OST could benefit from a more personalized approach intervention educating patients on coping mechanisms with no direct supervision.

The number of previous treatment attempts and duration of treatment were negatively associated with weight gain. Our qualitative research with PWUD in rehabilitation centers revealed that participants after several treatment attempts become aware of the weight gain that they will face in the early phases of rehabilitation and of the difficulties in losing it at later stages. As a result, they become more vigilant to the binging on foods [33]. Moreover, it is possible that the weight acquired during the previous treatment attempts, made it harder specifically for obese and overweight participants to gain further weight [61,63]. These findings need to be further explored as they could inform weight management prevention efforts in this population. Furthermore, participants with previous exposure to weight gain may provide positive peer support to cope with

cravings. Their preset knowledge of the obstacles faced in weight loss in later stages of the treatment is likely to insure better coping strategies in the weight gain intervention among their peers. Furthermore, and in support to our results, studies show that changes in weight and eating behaviors differed by the stage and duration of recovery [1;13]. Regaining weight lost in active drug use was dominant in the early phases of treatment and exceeded the weight lost during substance abuse [13]. This increase in food intake, thus weight, may be due to the need to maintain body weight to its suitable biological level, or to the compromised neurobiological system which makes food a compensation for the drug [64]. The dysfunctional eating practices and cravings improve in mid and later recovery phases, where the weight gained becomes a concern and a cause for anxiety and distress [1]. This finding should be confirmed by longitudinal measured weights in treatment centers and may suggest that any intervention among this population group should take the recovery stages into consideration.

Looking at other nutrition and lifestyle practices, our findings showed that nutrition knowledge, food addiction, physical activity level, and sleep quality were not associated with weight gain. Similarly, Sason et al. [65] showed that nutrition intervention programs among patients undergoing MMT led to increased nutrition knowledge without showing weight loss or changes in BMI. In contrast, Peles et al. [51] showed that subjects undergoing MMT with a high BMI scored lower on knowledge about healthy diet as compared with those with lower BMI. Furthermore, the evidence regarding the association between nutrition knowledge and healthy weight is inconclusive in the general population. Obese individuals and those of healthy weight had comparable levels of nutrition knowledge, suggesting that there may be other factors accounting for the higher BMI [66]. While education and knowledge provide the skills to choose better food options, it has been suggested that knowledge alone, albeit necessary, is typically insufficient to facilitate behavior change [67]. Addressing personal, behavioral and environmental barriers to dietary behavior change is an important component, in addition to nutrition knowledge, in any future health promotion model among this group [68].

Food addiction was another factor that did not show an association with weight gain in our study. Literature shows conflicting results regarding correlation of food addiction and weight gain among overweight and obese individuals in the general population [17,69,70]. Pursey et al. [71] reported that 24.9% of obese and overweight individuals had food addiction as compared to 11.1% in healthy weight persons. To our knowledge, there are no studies associating food addiction and weight gain

among PWUD. Drug use and food addiction have similar neurobiological pathways regarding expressions of dopamine. Repeated exposures to high sugar and high fat foods reduce dopamine release triggering the need for higher intakes, thus weight gain [71,72]. Although food addiction is more prevalent in participants with obesity, it has also been observed in a range of weight classes [73]. Thus, obesity should not be used as proxy for food addiction and longitudinal studies are needed to determine the temporal relation between food addiction and weight gain.

Furthermore, physical activity was not associated with weight gain among our sample. Physical activity has been advocated as a key behavioral component in prevention of weight gain in the general population [74,75]. The most consistent finding in cross-sectional studies indicates that a large volume of physical activity is associated with less weight gain [76-78]. On the other hand, randomized trials with physical exercise intervention show inconsistent results about this association [79]. Physical activity as a determinant of weight gain in PWUD undergoing treatment for recovery has not been addressed. One explanation for the lack of association seen in our sample could be due to the fact that it was not quantitatively measured but assessed using questionnaires depending on the participants' recall. Another explanation could be the high energy intake among PWUD in treatment [33]. Physical activity in PWUD undergoing treatment has shown extensive benefits in terms of reducing withdrawal symptoms, anxiety and depression [80,81]. Further longitudinal studies exploring the benefits of physical activity on weight gain reported in this population group is important. Moreover, investigating changes in body composition, specifically increases in muscle mass, from physical activity should be investigated. Rehabilitation centers are controlled environments for implementing behavioral changes and acceptance of healthy lifestyle intervention programs including structured physical activity and adequate nutritional meals as compared to OST centers.

Finally, no association was seen between weight gain and sleep. The sleep of PWUD in treatment for recovery has received little attention. The dearth of studies mainly emphasizes on patients undergoing MMT showing poor quality and quantity of sleep arising from psychopathological problems or the methadone itself [82,83]. The published literature shows conflicting results supporting the association between sleep and weight gain in adults. Cross sectional studies support the association between weight gain and poor sleep quality, whereas longitudinal studies have conflicting results with some showing diminishing association over time [84,85]. Individuals who are short sleepers do not continue to gain weight linearly over time [86]. In order for short sleep to predict

any physiological or behavioral change, the longitudinal time frame of the study would need to start at the beginning of the short sleep transition of the individual[87]. This could support our results as the sleep deprivation of PWUD starts during active drug use and continues across treatment. The weight gain observed could be attributed to the association with poor sleep quality at the beginning of the sleep deprivation and not at the time of the data collection. A possible mechanism attributed to this weight gain is that lack of sleep leads to hormonal imbalances with decreases in leptin and increases in ghrelin, leading to increases in food intake [88]. Sleep as a determinant of weight gain among PWUD in treatment centers has not been addressed. Further studies are warranted to confirm its association with weight gain over time.

Strengths and limitations

This study pioneers in exploring the weight change patterns and identifying the determinants of weight gain reported among PWUD undergoing treatment for recovery in the MENA region, specifically in Lebanon. Moreover, it fills a gap in the literature identifying weight change patterns across BMI categories and quality of sleep specifically in rehabilitation centers. Drug use has progressed tremendously in Lebanon after the civil war due to a more permissive sociocultural context. Furthermore, growing demands on the treatment centers in the country has been observed lately, mainly due to the ceasing of all judicial decisions against persons opting for treatment [36]. For these given reasons, addressing this population group is of importance aiming at developing health intervention programs tackling risk factors associated with the increase in weight gain observed. This study thus provides useful information in this regard. Also, this study fills a gap in the literature comparing the two treatment modalities. This may play an important factor in customizing intervention programs offered based on the type of treatment.

On the other hand, this study has some limitations. First, one important limitation is that the weight gain seen in our sample was reported and not measured. This study is a cross-sectional one and the participants were met for the first time during the data collection. Second, although the assessment tools used such as the YFAS [43], PSQI [44] and IPAQ [45] were validated, further validation among the population of PWUD is warranted, and the information provided is not measured, rather is on a recall basis. Third, poor lifestyle factors including alcohol and cigarette smoking were not adequately addressed in this study and maybe contributing factors to weight gain. Fourth, the dietary intake was measured once by 24- hour recall. This might not be representative of the

participants' usual intake, and is subject to recall and social desirability bias [89]. Fifth, female participants were not represented in the sample due to the limited number of female residential treatment centers and the fear of stigmatization among the OST group. Finally, we used the stepwise method in the multivariate regression analysis. This could be debated by the fact that it is recommended in exploratory and predictive research, where subject matter knowledge is limited like our study [90]. The interpretation of results should only be preliminary and should not assign meaningfulness to the order of variable entry and selection [91].

Future studies

Comparative studies between Lebanon and elsewhere should be conducted to assess whether our findings are shared features among PWUD in treatment for recovery and not specific to the Lebanese population. Furthermore, longitudinal studies examining the implications of the weight gain on diseases risk factors and hard outcomes among this population group at different treatment intervals are warranted. In addition to this, future studies investigating determinants of weight gain in each treatment modality separately are warranted. Moreover, validation of the tools used among PWUD is of importance for future research among this population group. Additionally, retrospective studies examining weight change from the time of initiation of poor sleep during active drug use and across treatment to confirm association. Finally, studies aiming at the development of health interventions targeting the significant weight gain during treatment from drug use disorder are of great importance.

Conclusion

Treatment from drug use is lifesaving, but is associated with meaningful weight gain that might lead to health risk factors. This weight gain was higher in the rehabilitation group and among people in the underweight, normal and overweight BMI categories. PWUD in treatment for recovery are a vulnerable group with poorly served needs. Treatment centers could benefit from further improvement to better serve their patients' needs, particularly with regards to nutrition and lifestyle parameters. Developing health promotion programs with the aim of improving the treatment process, diminishing health risk factors and preventing relapse is of great importance.

Acknowledgement:
We would like to acknowledge the support and the assistance of Dr. Hani Tamim in the statistical analysis of the data.

Author contributions: N.M was involved in the concept and design of the study, collected, analyzed and interpreted the data and drafted the manuscript. R.R. was involved in the concept and design of the study, contributed to data collection, analysis and interpretation, wrote original content and critically revised the manuscript. C. F. was involved in the data collection and the write up of the manuscript. N.V was involved in the concept and design of the study, wrote original content and critically revised the manuscript. All authors approved the final version of the manuscript.

Funding: This work was supported by the Institut National de Santé Publique, d'Epidémiologie Clinique, et de Toxicologie (INSPECT-LB), Beirut- Lebanon.

No conflicts of interest.

References

1. Neale J, Nettleton S, Pickering L, Fischer J. Eating patterns among heroin users: a qualitative study with implications for nutritional interventions. *Addiction*. Mar 2012;107(3):635-41. doi:10.1111/j.1360-0443.2011.03660.x

2. Tang AM, Bhatnagar T, Ramachandran R, et al. Malnutrition in a population of HIV-positive and HIV-negative drug users living in Chennai, South India. *Drug Alcohol Depend*. Oct 1 2011;118(1):73-7. doi:10.1016/j.drugalcdep.2011.02.020

3. Mahboub N, Rizk R, Karavetian M, de Vries N. Nutritional status and eating habits of people who use drugs and/or are undergoing treatment for recovery: a narrative review. *Nutrition Reviews*. 2020;doi:10.1093/nutrit/nuaa095

4. White R. Drugs and nutrition: How side effects can influence nutritional intake. *The Proceedings of the Nutrition Society*. 11/01 2010;69:558-64. doi:10.1017/S0029665110001989

5. Jeynes KD, Gibson EL. The importance of nutrition in aiding recovery from substance use disorders: A review. *Drug Alcohol Depend*. Oct 1 2017;179:229-239. doi:10.1016/j.drugalcdep.2017.07.006

6. Degenhardt L, Hall W. Extent of illicit drug use and dependence, and their contribution to the global burden of disease. *Lancet*. Jan 7 2012;379(9810):55-70.

7. Ersche KD, Stochl J, Woodward JM, Fletcher PC. The skinny on cocaine: insights into eating behavior and body weight in cocaine-dependent men. *Appetite*. 2013;71:75-80. doi:10.1016/j.appet.2013.07.011

8. Himmelgreen DA, Perez-Escamilla R, Segura-Millan S, Romero-Daza N, Tanasescu M, Singer M. A comparison of the nutritional status and food security of drug-using and non-drug-using Hispanic women in Hartford, Connecticut. *Am J Phys Anthropol*. Nov 1998;107(3):351-61.

9. Mysels DJ, Sullivan MA. The relationship between opioid and sugar intake: review of evidence and clinical applications. *J Opioid Manag*. Nov-Dec 2010;6(6):445-52.

10. Quach LA, Wanke CA, Schmid CH, et al. Drug use and other risk factors related to lower body mass index among HIV-infected individuals. *Drug Alcohol Depend*. May 1 2008;95(1-2):30-6. doi:10.1016/j.drugalcdep.2007.12.004

11. United Nations Office on Drugs and Crime (UNODC). *World Drug Report 2019* (United Nations publication, Sales No. E. 19. XI. 8).

12. J Edge P, S Gold M. Drug withdrawal and hyperphagia: lessons from tobacco and other drugs. *Current pharmaceutical design*. 2011;17(12):1173-1179.

13. Cowan J, Devine C. Food, eating, and weight concerns of men in recovery from substance addiction. *Appetite*. Jan 2008;50(1):33-42. doi:10.1016/j.appet.2007.05.006

14. Zahari Z, Siong LC, Musa N, et al. Report: Demographic profiles and sleep quality among patients on methadone maintenance therapy (MMT) in Malaysia. *Pak J Pharm Sci*. Jan 2016;29(1):239-46.

15. Peles E, Schreiber S, Adelson M. Documented poor sleep among methadone-maintained patients is associated with chronic pain and benzodiazepine abuse, but not with methadone dose. *Eur Neuropsychopharmacol*. Aug 2009;19(8):581-8. doi:10.1016/j.euroneuro.2009.04.001

16. Van Strien T, Herman CP, Verheijden MW. Eating style, overeating, and overweight in a representative Dutch sample. Does external eating play a role? *Appetite*. 2009;52(2):380-387.

17. Meule A, Gearhardt AN. Food addiction in the light of DSM-5. *Nutrients*. 2014;6(9):3653-3671. doi:10.3390/nu6093653

18. Lee NM, Hall WD, Lucke J, Forlini C, Carter A. Food addiction and its impact on weight-based stigma and the treatment of obese individuals in the US and Australia. *Nutrients*. 2014;6(11):5312-5326.

19. Lerma-Cabrera JM, Carvajal F, Lopez-Legarrea P. Food addiction as a new piece of the obesity framework. *Nutrition Journal*. 2015;15(1):1-5.

20. Meguid MM, Fetissov SO, Varma M, et al. Hypothalamic dopamine and serotonin in the regulation of food intake. *Nutrition*. 2000;16(10):843-857.

21. American Psychiatric Association (2013) *Diagnostic and Statistical Manual of Mental Disorders: Diagnostic and Statistical Manual of Mental Disorders*, 5th ed. Arlington, VA: American Psychiatric Association.

22. Müller DJ, Muglia P, Fortune T, Kennedy JL. Pharmacogenetics of antipsychotic-induced weight gain. *Pharmacological Research*. 2004/04/01/ 2004;49(4):309-329. doi:https://doi.org/10.1016/j.phrs.2003.05.001

23. Wetterling T, Müssigbrodt HE. Weight gain: side effect of atypical neuroleptics? *J Clin Psychopharmacol*. Aug 1999;19(4):316-21. doi:10.1097/00004714-199908000-00006

24. Nolan LJ, Scagnelli LM. Preference for Sweet Foods and Higher Body Mass Index in Patients Being Treated in Long-Term Methadone Maintenance. *Substance Use & Misuse*. 2007/09/21 2007;42(10):1555-1566. doi:10.1080/10826080701517727

25. Schlienz NJ, Huhn AS, Speed TJ, Sweeney MM, Antoine DG. Double jeopardy: a review of weight gain and weight management strategies for psychotropic medication prescribing during methadone maintenance treatment. *International Review of Psychiatry*. 2018;30(5):147-154.

26. Mysels DJ, Vosburg S, Benga I, Levin FR, Sullivan MA. Course of weight change during naltrexone vs. methadone maintenance for opioid-dependent patients. *Journal of opioid management*. 2011;7(1):47.

27. Romelsjö A, Leifman A. Association between alcohol consumption and mortality, myocardial infarction, and stroke in 25 year follow up of 49 618 young Swedish men. *Bmj*. 1999;319(7213):821-822.

28. Wansink B, Cheney MM, Chan N. Exploring comfort food preferences across age and gender. *Physiology & behavior*. 2003;79(4-5):739-747.

29. Sobal J, Nelson MK. Commensal eating patterns: a community study. *Appetite*. 2003;41(2):181-190.

30. Sweeney MM, Antoine DG, Nanda L, et al. Increases in body mass index and cardiovascular risk factors during methadone maintenance treatment. *Journal of opioid management*. Sep/Oct 2019;15(5):367-374. doi:10.5055/jom.2019.0526

31. Gottfredson NC, Sokol RL. Explaining Excessive Weight Gain during Early Recovery from Addiction. *Substance Use & Misuse*. 2019/04/16 2019;54(5):769-778. doi:10.1080/10826084.2018.1536722

32. Warren CS, Lindsay AR, White EK, Claudat K, Velasquez SC. Weight-related concerns related to drug use for women in substance abuse treatment: prevalence and relationships with eating pathology. *J Subst Abuse Treat*. May-Jun 2013;44(5):494-501. doi:10.1016/j.jsat.2012.08.222

33. Mahboub N, Honein-AbouHaidar G, Rizk R, de Vries N. People who use drugs in rehabilitation, from chaos to discipline: Advantages and pitfalls: A qualitative study. *PloS one*. 2021;16(2):e0245346.

34. Glasner-Edwards S, Mooney LJ, Marinelli-Casey P, et al. Bulimia nervosa among methamphetamine dependent adults: Association with outcomes three years after treatment. *Eating disorders*. 2011;19(3):259-269.

35. Mahboub N, Rizk R, de Vries N. Nutritional parameters and lifestyle practices of people who use drugs undergoing treatment for recovery in Lebanon: a descriptive study. *Journal of Nutritional Science*. 2021;10

36. Ministry of Public Health, Ministry of Education and Higher Education, Ministry of Interior and Municipalities, Ministry of Justice, and Ministry of Social Affairs 2016. *Inter-Ministerial Substance Use Response Strategy for Lebanon 2016-2021*. Beirut: Lebanon.

37. World Health Organization. Regional Office for the Eastern Mediterranean. (2012). *MENAHRA – The Middle East and North Africa Harm Reduction Association best practices in strengthening civil society's role in delivering harm reduction services*.

38. United Nations Office on Drugs and Crime (2017) *World Drug Report*. Vienna: United Nations Office on Drugs and Crime.

39. Moshfegh AJ, Rhodes DG, Baer DJ, et al. The US Department of Agriculture Automated Multiple-Pass Method reduces bias in the collection of energy intakes. *Am J Clin Nutr*. Aug 2008;88(2):324-32. doi:10.1093/ajcn/88.2.324

40. Raper N, Perloff B, Ingwersen L, Steinfeldt L, Anand J. An overview of USDA's Dietary Intake Data System. *Journal of Food Composition and Analysis*. 2004/06/01/ 2004;17(3):545-555. doi:https://doi.org/10.1016/j.jfca.2004.02.013

41. pellet p, Shadarevian,S. *Food Composition Tables for Use in the Middle East*. American University of Beirut; 1970.

42. Dickson-Spillmann M, Siegrist M, Keller C. Development and validation of a short, consumer-oriented nutrition knowledge questionnaire. *Appetite*. Jun 2011;56(3):617-20. doi:10.1016/j.appet.2011.01.034

43. Gearhardt AN, Corbin WR, Brownell KD. Preliminary validation of the Yale Food Addiction Scale. *Appetite*. Apr 2009;52(2):430-6. doi:10.1016/j.appet.2008.12.003

44. Buysse DJ, Reynolds CF, 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res*. May 1989;28(2):193-213. doi:10.1016/0165-1781(89)90047-4

45. Craig CL, Marshall AL, Sjostrom M, et al. International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc*. Aug 2003;35(8):1381-95. doi:10.1249/01.mss.0000078924.61453.fb

46. Haidar SA, de Vries NK, Papandreou D, Rizk R, Karavetian M. The Freshman Weight Gain Phenomenon: Does It Apply To. *Open access Macedonian journal of medical sciences*. 2018;6(11):2214-2220. doi:10.3889/oamjms.2018.431

47. Organization WH. Process of translation and adaptation of instruments. *http://www who int/substance_abuse/research_tools/translation/en/*. 2009;

48. Zolala F, Mahdavian M, Haghdoost AA, Karamouzian M. Pathways to addiction: a gender-based study on drug use in a triangular clinic and drop-in center, Kerman, Iran. *International journal of high risk behaviors & addiction*. 2016;5(2)

49. Mumtaz G. Estimating the prevalence of injecting drug use in the Middle East and North Africa. Hamad bin Khalifa University Press (HBKU Press); 2013:BIOP-031.

50. Montazerifar F, Karajibani M, Lashkaripour K. Effect of methadone maintenance therapy on anthropometric indices in opioid dependent patients. *Int J High Risk Behav Addict*. Fall 2012;1(3):100-3. doi:10.5812/ijhrba.4968

51. Peles E, Schreiber S, Sason A, Adelson M. Risk factors for weight gain during methadone maintenance treatment. *Subst Abus*. Oct-Dec 2016;37(4):613-618. doi:10.1080/08897077.2016.1179705

52. Emerson MH, Glovsky E, Amaro H, Nieves R. Unhealthy weight gain during treatment for alcohol and drug use in four residential programs for Latina and African American women. *Subst Use Misuse*. 2009;44(11):1553-65. doi:10.1080/10826080802494750

53. Chavez MN, Rigg KK. Nutritional implications of opioid use disorder: A guide for drug treatment providers. *Psychology of Addictive Behaviors*. 2020;34(6):699-707. doi:10.1037/adb0000575

54. Cowan JA, Devine CM. Process evaluation of an environmental and educational nutrition intervention in residential drug-treatment facilities. *Public Health Nutrition*. 2012;15(7):1159-1167. doi:10.1017/S1368980012000572

55. Fenn JM, Laurent JS, Sigmon SC. Increases in body mass index following initiation of methadone treatment. *J Subst Abuse Treat*. Apr 2015;51:59-63. doi:10.1016/j.jsat.2014.10.007

56. Grigson PS. Like drugs for chocolate: separate rewards modulated by common mechanisms? *Physiology & behavior*. Jul 2002;76(3):389-95. doi:10.1016/s0031-9384(02)00758-8

57. Hodgkins CC, Cahill KS, Seraphine AE, Frostpineda K, Gold MS. Adolescent Drug Addiction Treatment and Weight Gain. *Journal of Addictive Diseases*. 2004/07/29 2004;23(3):55-65. doi:10.1300/J069v23n03_05

58. Falahi E, Rad AHK, Roosta S. What is the best biomarker for metabolic syndrome diagnosis? *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*. 2015;9(4):366-372.

59. Fareed A, Casarella J, Amar R, Vayalapalli S, Drexler K. Benefits of retention in methadone maintenance and chronic medical conditions as risk factors for premature death among older heroin addicts. *Journal of Psychiatric Practice®*. 2009;15(3):227-234.

60. Howard AA, Hoover DR, Anastos K, et al. The effects of opiate use and hepatitis C virus infection on risk of diabetes mellitus in the Women's Interagency HIV Study. *Journal of acquired immune deficiency syndromes (1999)*. 2010;54(2):152.

61. Forbes GB. Do obese individuals gain weight more easily than nonobese individuals? *The American journal of clinical nutrition*. 1990;52(2):224-227.

62. Volkow ND, Wang GJ, Tomasi D, Baler RD. Obesity and addiction: neurobiological overlaps. *Obesity reviews*. 2013;14(1):2-18.

63. Forbes GB. Lean body mass-body fat interrelationships in humans. *Nutrition reviews (USA)*. 1987;

64. Wang GJ, Volkow ND, Thanos PK, Fowler JS. Similarity between obesity and drug addiction as assessed by neurofunctional imaging: a concept review. *Journal of addictive diseases*. 2004;23(3):39-53. doi:10.1300/J069v23n03_04

65. Sason A, Adelson M, Herzman-Harari S, Peles E. Knowledge about nutrition, eating habits and weight reduction intervention among methadone maintenance treatment patients. *J Subst Abuse Treat*. Mar 2018;86:52-59. doi:10.1016/j.jsat.2017.12.008

66. O'brien G, Davies M. Nutrition knowledge and body mass index. *Health education research*. 2007;22(4):571-575.

67. Steptoe A, Perkins-Porras L, McKay C, Rink E, Hilton S, Cappuccio FP. Psychological factors associated with fruit and vegetable intake and with biomarkers in adults from a low-income neighborhood. *Health Psychology*. 2003;22(2):148.

68. Wardle J, Parmenter K, Waller J. Nutrition knowledge and food intake. *Appetite*. 2000;34(3):269-275.

69. Masheb RM, Ruser CB, Min KM, Bullock AJ, Dorflinger LM. Does food addiction contribute to excess weight among clinic patients seeking weight reduction? Examination of the Modified Yale Food Addiction Survey. *Compr Psychiatry*. Jul 2018;84:1-6. doi:10.1016/j.comppsych.2018.03.006

70. Pedram P, Wadden D, Amini P, et al. Food addiction: its prevalence and significant association with obesity in the general population. *PLoS One*. 2013;8(9):e74832. doi:10.1371/journal.pone.0074832

71. Pursey KM, Stanwell P, Gearhardt AN, Collins CE, Burrows TL. The prevalence of food addiction as assessed by the Yale Food Addiction Scale: a systematic review. *Nutrients*. 2014;6(10):4552-4590.

72. Stice E, Figlewicz DP, Gosnell BA, Levine AS, Pratt WE. The contribution of brain reward circuits to the obesity epidemic. *Neuroscience & Biobehavioral Reviews*. 2013/11/01/ 2013;37(9, Part A):2047-2058. doi:https://doi.org/10.1016/j.neubiorev.2012.12.001

73. Schulte EM, Grilo CM, Gearhardt AN. Shared and unique mechanisms underlying binge eating disorder and addictive disorders. *Clinical psychology review*. 2016;44:125-139.

74. Jeffery RW, Epstein LH, Wilson GT, Drewnowski A, Stunkard AJ, Wing RR. Long-term maintenance of weight loss: current status. *Health psychology*. 2000;19(1S):5.

75. Wing RR. Physical activity in the treatment of the adulthood overweight and obesity: current evidence and research issues. *Medicine and science in sports and exercise*. 1999;31(11 Suppl):S547-52.

76. Bell AC, Ge K, Popkin BM. Weight gain and its predictors in Chinese adults. *International journal of obesity*. 2001;25(7):1079-1086.

77. Ravussin E, Gautier J. Metabolic predictors of weight gain. *International Journal of Obesity*. 1999;23(1):S37-S41.

78. Williamson DF. Dietary intake and physical activity as" predictors" of weight gain in observational, prospective studies of adults. *Nutrition reviews*. 1996;54(4):S101.

79. Fogelholm M, Kukkonen-Harjula K. Does physical activity prevent weight gain–a systematic review. *Obesity reviews*. 2000;1(2):95-111.

80. Gimenez-Meseguer J, Tortosa-Martinez J, de los Remedios Fernandez-Valenciano M. Benefits of Exercise for the Quality of Life of Drug-Dependent Patients. *J Psychoactive Drugs*. Nov-Dec 2015;47(5):409-16. doi:10.1080/02791072.2015.1102991

81. Roessler KK. Exercise treatment for drug abuse--a Danish pilot study. *Scand J Public Health*. Aug 2010;38(6):664-9. doi:10.1177/1403494810371249

82. Stein MD, Herman DS, Bishop S, et al. Sleep disturbances among methadone maintained patients. *J Subst Abuse Treat*. Apr 2004;26(3):175-80. doi:10.1016/s0740-5472(03)00191-0

83. Beswick T, Best D, Rees S, Bearn J, Gossop M, Strang J. Major disruptions of sleep during treatment of the opiate withdrawal syndrome: differences between methadone and lofexidine detoxification treatments. *Addict Biol*. Mar 2003;8(1):49-57. doi:10.1080/1355621031000069882

84. Chaput J-P, Després J-P, Bouchard C, Tremblay A. The association between sleep duration and weight gain in adults: a 6-year prospective study from the Quebec Family Study. *Sleep*. 2008;31(4):517-523.

85. Patel SR, Hu FB. Short sleep duration and weight gain: a systematic review. *Obesity (Silver Spring, Md)*. 2008;16(3):643-653. doi:10.1038/oby.2007.118

86. Gangwisch JE, Malaspina D, Boden-Albala B, Heymsfield SB. Inadequate sleep as a risk factor for obesity: analyses of the NHANES I. *Sleep*. 2005;28(10):1289-1296.

87. Magee L, Hale L. Longitudinal associations between sleep duration and subsequent weight gain: a systematic review. *Sleep medicine reviews*. 2012;16(3):231-241.

88. Wiss DA. A biopsychosocial overview of the opioid crisis: Considering nutrition and gastrointestinal health. *Frontiers in public health*. 2019;7:193.

89. Johnson RK. Dietary intake--how do we measure what people are really eating? *Obesity*. 2002;10(s11):63S.

90. Genell A, Nemes S, Steineck G, Dickman PW. Model selection in medical research: a simulation study comparing Bayesian model averaging and stepwise regression. *BMC medical research methodology*. 2010;10(1):1-10.

91. Lewis M. Stepwise versus Hierarchical Regression: Pros and Cons. 2007. Accessed June 03, 2021 https://files.eric.ed.gov/fulltext/ED534385.pdf.

Chapter 6

General Discussion

In Lebanon, recently, there has been a growing demand on Substance Use Disorder (SUD) treatment centers, reflective of the growth of drug use in the country. A combination of factors including the civil war and the near hibernation of the government apparatus has delayed the development of specialist services including substance use treatment. The scarce available data on practices applied in drug treatment centers focus on the implementation of harm reduction services to limit the spread of infectious diseases and levels of criminality among this population group (MENHARA, 2021). To our knowledge, there is a dearth of studies comprehensively assessing lifestyle practices and health risks among PWUD in treatment. Addressing this issue is of great importance as findings might have implications on the health status of the individuals and may be used for further education and intervention in SUD treatment.

In this thesis, we collected dietary, anthropometric, biochemical, and lifestyle data from a sample of PWUD undergoing treatment in OST and rehabilitation centers in Lebanon, and explored their practices qualitatively and quantitatively. We assessed the differences in these practices across the two treatment modalities. We also investigated the patterns and determinants of weight gain seen in PWUD undergoing treatment for recovery. We open this chapter by presenting the main findings of the thesis, followed by the methodological limitations, strengths of the study and implications for future research. Finally, we conclude with future health promotion recommendations to be implemented in SUD treatment centers in Lebanon.

Main Findings of the Thesis

- Drug use is characterized by a chaotic lifestyle with poor food intake, disrupted sleep, and low physical activity, moving to a more disciplined routine during treatment, coupled with improvements in the anthropometric and metabolic parameters of PWUD.
- Weight gain and poor sleep occur among the majority of the participants during treatment, significantly higher in the rehabilitation centers.
- Higher weight gain in the rehabilitation group is seen among people in the underweight, normal, overweight and obese BMI categories.
- Weight gain was negatively associated with the number of previous quit attempts, duration of current treatment and pre-treatment BMI.
- Low physical activity levels are found among the majority of the participants, significantly lower among PWUD undergoing treatment in OST as compared to rehabilitation centers.
- Poor nutrition knowledge and high food addiction are observed among the majority of the participants, without significant differences between PWUD undergoing treatment in rehabilitation and OST centers.
- Challenges faced in rehabilitation centers:
  - Increased food intake and weight gain that is perceived as a health indicator and the sole distraction from drugs posing health implications and risk of relapse.
  - Lack of variety of physical activity programs, not taking the motivational differences among the participants into consideration.

Nutritional status and eating habits of people who use drugs and/or are undergoing treatment for recovery: A narrative review

In ***Chapter 2***, PubMed, Google Scholar, Science Direct, and Medline were searched for articles addressing the nutritional status and dietary habits of people actively using drugs and those in treatment. In this work, we reviewed 91 studies, where we opted for a qualitative synthesis given the diversity of topics in this field with few studies targeting each, making statistical combination difficult.

Substantial evidence supports decreased food intake, irregular eating patterns, and increased preference for sweet taste among PWUD. Furthermore, an inverse correlation between drug use and body weight and BMI was noted. This correlation was modulated by the high frequency and the route of administration of the drug. Plasma and dietary micronutrients were shown to be below the recommended levels.

Regarding users in treatment, scarce available data indicate improvements in the anthropometric and metabolic parameters when initiating treatment, but with micronutrients remaining under the recommended intakes. An increase in weight is noted, which might pose negative health implications. Concerns about weight gain, especially among females, in recovery is seen as a potential risk factor for relapse. All of the above factors draw attention to the importance of proper comprehensive nutrition care being provided for drug users and in treatment centers.

People who use drugs in rehabilitation, from chaos to discipline: Advantages and pitfalls: A qualitative Study

In ***Chapter 3***, we pioneered in qualitatively exploring the dietary intake, sleep, and physical activity of PWUD undergoing treatment in rehabilitation centers in Lebanon, aiming to generate information for the development of a future intervention program in these centers.

We found that rehabilitation centers enforce a disciplined routine lifestyle practice in terms of nutrition, sleep, and physical activity that was appreciated by most participants. Yet, this strict regimen was viewed as suboptimal as it should address individuals' preferences and needs in terms of binge eating, lack of sleep, and type and frequency of physical activity offered. Furthermore, follow-up treatment in the community, providing a continuity of care, at the end of the rehabilitation period was also expressed as a need among most of the participants. This study sheds

light on the importance of backing up these findings quantitively due to the absence of any relevant data in this population group.

Nutritional parameters and lifestyle practices of people who use drugs undergoing treatment for recovery in Lebanon: A descriptive study

In ***Chapter 4,*** we assessed the nutritional status, anthropometric measures, dietary intake, nutrition knowledge, food addiction, and biochemical profiles, as well as sleep and physical activity of PWUD undergoing treatment for recovery in Lebanon. Furthermore, we explored major differences in these parameters between the two offered treatment modalities: (extramural) OST and (intramural) rehabilitation.

Our results showed that PUWD undergoing treatment for recovery were subject to excessive weight gain that was significantly higher among those undergoing rehabilitation. Poor sleep quality was also significantly higher in the rehabilitation group, whereas physical activity was lower in the OST centers. Finally, poor nutrition knowledge and high food addiction level were seen in both treatments with no significant difference between them.

These practices should be investigated by future studies in other countries in the region, to explore whether they are shared features among this patient population or unique characteristics of PWUD treated in Lebanon. Furthermore, it is important to assess the health impact of these practices among this population group.

Patterns and determinants of weight gain among people who use drugs undergoing treatment for recovery in Lebanon

Weight gain and poor lifestyle practices in healthy individuals have been attributed to increased risk of chronic diseases such as diabetes, cardiovascular diseases, and psychological disorders. In ***Chapter 5,*** we aimed to examine the patterns and extent of weight change in PWUD undergoing treatment for recovery in Lebanon. Moreover, we explored the differences in these variables between people receiving OST and those undergoing rehabilitation, and aimed to explore the determinants of weight gain in this population.

Looking at weight changes across different pre-treatment BMI categories and treatment modalities, our results showed that the majority of the participants who were initially in the underweight, normal, and overweight categories mainly gained weight during treatment and

moved to a higher BMI category in both treatment modalities. This shift in the BMI was significantly higher in the rehabilitation group. On the other hand, the majority of the participants who were initially obese maintained their status. We also found that the number of previous treatment attempts and duration of treatment were negatively associated with weight gain. Such data are crucial for weight normalization in underweight patients and obesity prevention in others to assess the long-term health impact and decrease the risk of non-communicable diseases among this population group.

Strengths of the studies

This thesis pioneered in assessing the nutritional, lifestyle and biochemical parameters of PWUD undergoing treatment for recovery in Lebanon and the Middle East region qualitatively and quantitatively. Additionally, it explored the weight change patterns and identified the determinants of weight gain reported among this population group. Accordingly, this work fills a gap in the international literature in terms of exploring health-related parameters in PWUDs undergoing treatment for recovery and comparing these parameters between patients undergoing different treatment modalities where striking dissimilarities were highlighted. We strived to recruit a large sample despite challenges faced, as this topic is considered a taboo in the region, making the access to treatment centers difficult. Furthermore, data collection was conducted by licensed dietitians, nurses, and phlebotomists, using validated questionnaires, that were appropriately translated to Arabic.

Methodological limitations

It is important to acknowledge that there are several limitations with the studies conducted to produce this thesis. Female participants were less represented compared with males and this is due to the limited number of rehabilitation centers in Lebanon accommodating females and the fear of stigma among females receiving OST. Second, the pre-treatment weight, BMI, change in usual dietary intake (a component of the SGA), sleep, and physical activity were reported by the participants and not measured. Despite the importance of reported data in exploratory studies, these parameters should be further examined using other techniques. Similarly, dietary intake was measured using a single 24-hour dietary recall which might not reflect the usual food intake, but might generate some insights on the intake of the participants. Third, no baseline data for

biochemical and nutritional parameters were present to compare our results and explore the impact of the treatment due to the cross-sectional design of the study. Fourth, it is possible that, because participants were still actively involved in the rehabilitation services when collecting the data, their responses may have been more socially desirable to avoid conflict with their host institution. Fifth, alcohol and cigarette smoking were not addressed and may be a contributing factor to the weight gain observed. A further limitation is that the Arabic versions of the translated questionnaires used in the study still need to undergo psychometric validation for future use. Moreover, this study would have benefited from a comparison against an aged-matched control group; nevertheless, this was impossible due to the lack of data regarding the variables studied in the general Lebanese population. Finally, the social and economic hardships that Lebanon is facing pose further challenges to the participants affecting their nutrition and lifestyle factors. Hence, the generalizability of our results may be limited and future studies in other countries will confirm whether our findings are shared features among this population, or unique characteristics of PWUD treated in Lebanon.

Current practices in substance use disorder treatments

SUD is a serious concern to societies due to the negative health, social, and economic effects on the development of communities (Karajibani et al., 2014). Specifically, SUD is marked with numerous potentially harmful habits leading to deteriorating effects on health and quality of life. Despite this, it is still one of the most common mental health problems in the western world with a significant level of unmet treatment need (Copeland & Martin, 2004; Pathare et al., 2018; Walker et al., 2015). Substance use has a tipping point that leads to pursuing treatment due to a variety of internal and external motives like acknowledgement of the negative physical and psychosocial consequences of drug use, fear, legal pressure, and family and peer motivation (Daley, 2013).

Accepting SUD as a health concern resulted in the provision of different types of treatments for different groups in the community. The early efforts for drug treatment were mainly based on short-term detoxification and residential treatment, while the recent methods of drug treatment are more based on opiate maintenance therapies and harm reduction programs (Alam-Mehrjerdi et al., 2015). While treatment interventions vary, there is a growing need for effective substance use treatment as the field lacks consensus-based best practice treatment guidelines (de Andrade et al., 2019). The effectiveness of treatment programs for SUD is not only measured by how well they

succeed in reducing or eliminating substance use, but also by how well they succeed in improving other aspects of clients' lives (McLellan et al., 1996). Three outcome criteria are used for judging the effectiveness of treatment from SUD: 1) reduction in substance use, 2) improvement in personal health and social function, and 3) reduction in public health and safety risks (Prendergast et al., 2001). Evaluating and comparing the effectiveness of different treatment services face challenges as the outcomes measured vary from abstinence, reduction in substance use, and harm reduction based on the treatment modality.

Moderate quality evidence shows improvements in substance use, mental health, social functioning, and perceived quality of life outcomes in residential treatment centers (Cleary et al., 2009; Drake et al., 2008). The best practice approach followed in these centers is the one that aims to improve the overall health and wellbeing of the individual beyond substance dependence, and provides continuity of care post-discharge (de Andrade et al., 2019).

Improving the health behaviors of people accessing SUD treatment should continue to be a priority for service providers (Kelly et al., 2021). Individually tailored interventions that combine guidance on exercise, diet, and smoking cessation show promise in addressing health promotion in PWUD undergoing treatment. Integrating such programs into contemporary treatments enhanced evidence-based practice in SUD treatment (Juel et al., 2017).

Moreover, methadone and buprenorphine treatment show statistically significant improvements in opioid use, psychiatric status, and quality of life of PWUD in treatment (Maremmani et al., 2007; Simpson et al., 1997).

The science–practice gap in substance use treatment

Although substance abuse professionals are generally open to new and better effective therapeutic methods, most evidence-based treatments and innovations in substance abuse treatments do not easily find their way into practice, yielding a widely acknowledged gap between science and standard practice (Miller et al., 2006). Subsequently, one of the foremost goals for the new millennium for the National Institute on Drug Abuse (NIDA) is the improvement of substance use treatment nationwide with the use of science as the vehicle (Khalsa et al., 2008). Most of these activities focus on both pharmaceutical and psycho-social therapy-based interventions (Compton et al., 2005). Overall, these protocols test the use of mixed medication therapies, motivational enhancement therapies, and motivational incentives (Hanson et al., 2002).

In addition to this, client physical health is recognized as integral background information needed in the treatment assessment (Barker et al., 1993). The clients' health status at treatment entry has been shown to predict subsequent health status following substance use treatment (Joe et al., 2019). Furthermore, poor health status might be considered as a barrier to treatment engagement. Additionally, indicators of poor well-being have been viewed as potential factors in relapse. Drug treatment programs may be interested in evaluating the health problems of their clients as this may provide material for discussion in counseling showing that the counselor and treatment program are interested not only in the client's drug problems, but also the client's overall health (Newman, 1997).

Recently, there is a focus in the mental health literature on implementing integrated lifestyle interventions as part of routine care of PWUDs undergoing treatment for recovery (Deenik et al., 2020). Such interventions are increasingly being recognized as important components of treatment for this vulnerable population, yet translating this evidence into a feasible and sustainable system implemented in clinical care is challenging (Suetani et al., 2016). Developing an implementation framework to support such change must be an urgent priority if we are to bridge the huge gap existing (Stewart, 2015). For example, in the United States, community-based treatment programs that provide most of the drug abuse treatment services have faced many obstacles in implementing research in clinical settings resulting in limited exchange of knowledge between researchers and clinical practitioners (Brigham et al., 2009). The successful development and implementation of a new behavioral treatment can be conceptualized as progressing through several stages of science, to dissemination, and finally, adoption (Institute of Medicine, 1998). It requires more understanding of the patients' needs, in addition to identifying facilitators and barriers experienced by both users and health providers (Brigham et al., 2009). Lack of preparation and hesitation of providers to adopt and implement science-based innovations can be due to several factors including: limited understanding of potential benefits, insufficient resources or expertise, and lack of tolerance necessary for full maturation of payoffs (Dwayne Simpson, 2009; Saloner et al., 2018). Moreover, other organizational change research has identified the need to reduce cynicism among employees through role modelling by transformational leaders (Bommer et al., 2005). Furthermore, dissemination of knowledge-focused material and workshops, as the sole components of an intervention, are relatively ineffective in helping practitioners gain proficiency in new approaches (Davis et al., 1995). To acquire new behavioral skills, proper training, feedback,

and supervision are required from expertise in the field (Miller et al., 2006). Moreover, physicians and programs with any involvement in research are more likely to adopt treatment innovations (Forman et al., 2001; McGovern et al., 2004). Finally, funding sources often provide little support for practitioners in learning new approaches, and most training is done on-the-job (Miller et al., 2006).

Bringing researchers and practitioners together to discuss issues, conducting research projects in community clinics, and producing materials for staff training are a start, but are not sufficient preconditions to change the system. A tremendous amount of training will be needed to initiate and maintain new practices. Policy change, political will, and funds are necessary to push this agenda forward. Blending science and practice is far from a done deal and cautious optimism is warranted (Rawson et al., 2002).

In planning health promotion interventions, conducting a (health) needs assessment is an essential first step. Our findings in this research shed the light on important needs to be addressed in terms of weight gain, food addiction, nutrition knowledge, and quality of sleep among PWUD in treatment centers in Lebanon. Furthermore, this research identified some barriers to adapting healthier lifestyle behaviors addressed by the participants and health care providers such as uncontrolled meal portions, unhealthy food choices, lack of variation in physical activity programs, and limited funds for having a nutritionist as part of the health care team. Moreover, it proposed some of the expectations of the participants in terms of lifestyle intervention programs. This data fills an important gap in the literature about the needs of this population group in the region; hence, providing the foundation of a framework for a health intervention program targeting nutrition and lifestyle practices of PWUD in treatment in Lebanon.

Burden of non-communicable diseases in substance use disorder treatment

Although mortality rates among PWUD are extremely high, studies show that a large proportion will survive to an age where non-communicable diseases become the main cause of death and morbidity (Lewer et al., 2020). Cause-specific mortality can be difficult to interpret as SUD itself is a non-communicable disease, but the majority of morbidity and mortality in this population is related to long term diseases such as cardiovascular and respiratory disorders and not drug itself (Lewer et al., 2019). The health needs of people with SUD or in treatment at later stages are likely to relate primarily to non-communicable diseases, rather than infections or drug-related factors

(Lewer et al., 2020; Peles et al., 2016). Accordingly, an additional burden of morbidity is becoming realized among those recovering from substance use disorders. Causes of death shifted from communicable to non-communicable diseases that occurred later in life (Rehm & Probst, 2018). Emerging evidence shows that people in SUD treatment have a poor life expectancy that is largely attributed to non-communicable diseases, particularly related to poor cardio-metabolic health (Matthews et al., 2021). Modifiable cardiometabolic risk factors, such as physical inactivity, smoking, and dietary risks contribute significantly to these negative health outcomes (De Leon & Diaz, 2005; Peles et al., 2016; Teasdale et al., 2019). Despite the fact that SUD treatment presents an opportunity to address health, holistically, available evidence shows that people often continue to adopt lifestyle behaviors that are health damaging during treatment (Comiskey et al., 2009; Zirakzadeh et al., 2013). SUD treatment might present an overlooked opportunity to improve patient outcomes, specifically those affected by non-communicable diseases, Hence, assessing and addressing nutrition and lifestyle practices among this population group is of great importance as it might predict subsequent health status following substance use treatment.

However, environmental differences between treatment modalities might influence the effectiveness of a health promotion program. Despite the evidence supporting OST treatment as a public health measure preventing the spread of diseases, the published literature is not yet clear on what is the optimal framework that might include intervention programs due to lack of control on external factors influencing patients' behaviors. This knowledge would be of great benefit for policy makers and treatment providers in order to promote effective interventions that would contribute towards the improvement of users' quality of life (Kourounis et al., 2016). On the other hand, rehabilitation centers provide a stable environment to target these multiple health risk behaviors under controlled condition of the participants daily lives (Kelly et al., 2015).

Little is known about the extent of metabolic abnormalities and their predictors among PWUD in treatment in Lebanon and the region. Our unpublished data revealed that 22.7% of the participants were diagnosed with metabolic syndrome (MS). MS represents a cluster of modifiable cardiovascular risk, which if not treated, can lead to an emerging clinical challenge in non-communicable diseases. This thesis has already established the need for dietary and lifestyle modifications paving the way for future studies examining the association between these lifestyle habits and the occurrence of MS in this population group. The implementation of primary

prevention methods like routine screening and multidisciplinary management of medical and behavioral conditions should be recommended.

Substance use disorder treatment in Lebanon: Perceptions of health care providers and program directors

Looking at treatments for substance use offered in Lebanon, the main objectives of the in-patient rehabilitation programs centers are long lasting abstinence, minimizing medical and social complications resulting from substance use, and reintegration of the patient in the main stream society. Support groups and education sessions on the psychology of addiction is provided to the patients' friends and families within the framework of a holistic approach to SUD treatment. This multidisciplinary approach is achieved by a team of physicians, psychotherapists, and social workers.

Close attention is paid to dealing with abstinence from drug use, but the effect of abstinence on weight gain and lifestyle practices is not addressed; this problem is multifactorial. Our unpublished qualitative information collected from health care providers in rehabilitation centers indicate that they are aware of the future health consequences of weight gain during treatment but claim that this is not the main target of the treatment: "*We can help if possible but this is not our responsibility*". Moreover, the patients' families express joy and content with the weight gain seen making it difficult for the health care providers to address it as a problem: "*We do not want a clash with the family*".

Moreover, treatment providers expressed surprise towards our results showing low participation in physical activity claiming that it is offered for all. Tailoring physical exercise interventions to the unique needs and preferences of the SUDs people under treatment was met with sarcasm when suggested. "*We are not a gym to choose what they like*" was the response, even when we mentioned that this is a crucial element for successful exercise intervention (Abrantes et al., 2011) and that the person-centered approach might be effective, because of the participants' varying fitness levels and underlying medical conditions (Kremer et al., 1995; Thompson et al., 2020).

On the other hand, the concept of harm reduction has slowly been gaining ground in the MENA region despite strong resistance from local authorities and traditional drug treatment centers. This effort brought forward opioid substitution in Lebanon in 2011. The introduction of OST to Lebanon has had a significant impact on the clinical practice in a short period of time, yet it has

been difficult to prove this success due to the absence of reliable figures on the opioid problem in Lebanon (Karam et al., 2010; Karam et al., 2004). OST centers in Lebanon rely mainly on pharmacotherapy with psychologists and psychiatrists offering evidence-based behavioral therapy only in indicated cases. OST life also has a darker side, as the treatment does not automatically rehabilitate the client. Contrary to rehabilitation centers, less weight gain or even weight loss was seen among our sample population. Despite the control measures and sanctions that centers try hard to apply, a big percentage of buprenorphine users continue to use illicit drugs often leading to decreased food consumption and disrupted eating patterns at the early stages of treatment (Uhl, 2007). Moreover, the economic hardships and financial burdens to support their families may be a major contributing factor (Alves, 2011). At later stages, addressing weight gain issues with the patients who are seeking treatment is not a priority as it might discourage them from continuing the treatment: "*Our priority is to stabilize the patient, later if he addresses weight gain issues, he can be referred to a social worker to discuss it*".

Moreover, OST participants were less engaged in physical activity as compared with participants undergoing rehabilitation. This is attributed to the lack of physical activity programs offered in OST and it being an external individualized effort. The individual recovering from SUD needs to be made aware of the physical and mental benefits of exercise (Kremer et al., 1995).

Looking at the poor sleep quality of PWUD in rehabilitation and OST centers, it can only be hypothesized that it is attributed to the drug withdrawal symptoms as no scientific evidence is presented in the literature.

Implications of the findings in clinical practice

Preventing weight gain, increasing physical activity, and enhancing quality of sleep in SUD treatment is important to prevent future health consequences and risk of relapse. Therefore, we suggest it is necessary for treatment centers to assess the nutritional and lifestyle practices of their patients and subsequently implement evidence-based health promotion intervention programs. These programs aim at increasing nutrition knowledge and guide patients to adopting healthy lifestyle and dietary habits.

There is scarcity of studies involving interventions addressing health behaviors in SUD treatment. These intervention studies address nutrition, sleep, and physical activity separately using mostly group-based education-based programs with no conceptual framework combining all health risk

behaviors. Moreover, most of these programs are only offered in SUD residential centers with few of these facilities utilizing the services of a dietitian (Wiss et al., 2019). In general, results showed positive changes across targeted health behaviors mainly in early phases following the intervention (Happell et al., 2012). Substance abuse treatment patients should have the same benefits of education as patients with other chronic diseases targeting specific risk factors of this population group (Finnell, 2000). As such, health behavior intervention programs might hold great promise as therapeutic strategies, but a synthesis of evidence for the effectiveness of these interventions is warranted.

Moreover, we can further postulate that the two treatment modalities are different not only in the services offered, but also in the environment in which the patients are to receive the treatment. Any intervention program addressing the nutrition and lifestyle practices has to have different components based on the type of treatment.

In rehabilitation centers, our findings highlight a behavioral interaction between the stage of recovery, living environment, and food choices leading to increased intake and subsequently weight gain. Thus, the need for restructuring treatment programs so that eating behaviors and nutrition education address specific needs at each stage of recovery is recommended. Weight gain issues should be targeted more systematically through building nutrition skills at different stages of recovery. Entering treatment for recovery from substance use in rehabilitation centers involved a transition to a disciplined and structured daily routine embedded in an environment providing substantial support. Considerable research now indicates that social support reduces the adverse psychological impacts of exposure to stressful life events and strains (Thoits, 1986). It is a transformative phase where the participants separated from their old identity that was based on chaotic unhealthy substance use behaviors and started engaging in healthy ones. As PWUD in treatment move from one stage to another in recovery, they develop new skills (Gorski, 1990). There is evidence that supports a developmental process with eating behaviors as well as weight changes in recovery (Gorski, 1990). Dysfunctional and binge eating patterns observed at the early stages of the recovery due to the availability of foods, its use as a replacement for drugs, or alleviation of boredom was replaced by a more structured pattern of intake in later stages of recovery (Cowan & Devine, 2008). This provides support with a stage recovery interpretation. Addressing healthy weight goals early in recovery and methods to achieve it should be part of the treatment goals. Patients initiating treatment should be informed that the weight gain in early

recovery may exceed the weight loss during substance use and that it may be a concern at later stages. Furthermore, these findings can also be consistent with environmental interpretations where the environment has been identified as an influence on food choices leading to weight gain (Jeffery & Utter, 2003). There is a general agreement that the causes of obesity are most likely to be found in changes in environmental conditions leading to increased levels of food consumption (Nielsen & Houborg, 2015). The increased availability of foods, in particular caloric dense ones, offered in rehabilitation centers may be a contributing factor to environmental influences. Given this, healthy food items served on the daily menu, in addition to incorporating healthy snacks during the day should be implemented. Furthermore, and as a step to encourage and increase physical activity in rehabilitation centers; age, health status, level of physical fitness and preference should be screened prior to determining the best fit type of exercise for each individual so as to guarantee continuity and progress.

Nutrition and lifestyle interventions can also be an important part of harm reduction approaches aimed at decreasing food insecurity and increasing quality of life in those who are not totally abstinent. Overlooking the importance of food in SUD treatment contexts may be a missed opportunity for public health (Wiss et al., 2021). In OST centers the patients pick up their medications with minimal interaction in the surrounding environment. Hence, there is a need for treatment practices to engage with the drug users' lives outside the treatment setting and act toward things that were previously ignored.
In both modalities the attitudes of the health care providers towards the need and importance of such programs should be assessed and addressed, in addition to family education and involvement.

Unfortunately, as raised by some program directors of centers involved in our study, ministries in Lebanon are not aware of the problems faced in terms of nutrition and lifestyle practices, and their role is limited only to supplying medications and partial funding for the centers. Most studies and funds are conducted by the efforts of NGOs. Therefore, treatment centers in collaboration with NGOs and academics should be proactive and take initiative in implementing such programs that can positively influence PWUD in treatment, enabling them to pursue a healthy lifestyle. Furthermore, the findings of this study should be disseminated to program directors, health practitioners in treatment centers, MOPH, Ministry of Social Affairs, and NGOs as they should be

attentive about the fact that this vulnerable population is not immune to chronic disease, and should be proactively screened for cardiometabolic risk and disease.

Future studies

We have established in this thesis that PWUD undergoing treatment for recovery in Lebanon are an overlooked population in terms of nutritional and lifestyle practices. Moreover, this group's vulnerability in these factors might negatively impact their health, treatment outcomes, and risk of relapse. We emphasize that further extensive research should be carried out in this population group for generating policies to enhance treatment of PWUD tackling all aspects of behavioral changes. To achieve this, future longitudinal studies are needed to examine changes in lifestyle practices, biochemical indices and weight throughout all stages of recovery and study their implications on the treatment outcome and disease development. Furthermore, future studies should recruit a more representative sample in terms of size and gender division to ensure generalizability of the results. Moreover, similar studies should be conducted elsewhere to explore whether our findings are common feature among PWUDs undergoing treatment for recovery or subject to a cultural artifact. When designing future longitudinal studies, inclusion of measured, not reported, parameters like dietary intake, weight and weight change, sleep, and physical activity is important to better assess patterns of weight gain and explore the individualized needs in terms of type and duration of physical activity to be adopted. Interestingly, the two treatment modalities offered in Lebanon showed different characteristics in terms of the variables studied. Future studies should aim to investigate the determinants of weight gain, in each treatment separately as different predictors might show influencing policy making. Furthermore, validation of the tools used in this study among PWUD is warranted for better reliability of results.

Despite all limitations, we were able to provide baseline assessment data and identify this population as a vulnerable group to weight gain, poor sleep, low physical activity, food addiction, and poor nutrition knowledge. All these factors will put this group at risk of developing future chronic diseases. Therefore, our findings give us confidence to address this topic proactively with relevant NGOs, stakeholders, and ministries to raise awareness about these issues, justify the need for additional research, and encourage the implementation of an evidence-based health promotion intervention in treatment centers.

Finally, we suggest that whatever the intervention that would be planned in the future it should be based on IM. It is a systematic approach composed of six steps that provides a framework for effective decision making through the steps of planning, implementation, and evaluation which will be addressed in the valorization chapter.

References

Abrantes, A. M., Battle, C. L., Strong, D. R., Ing, E., Dubreuil, M. E., Gordon, A., & Brown, R. A. (2011). Exercise preferences of patients in substance abuse treatment. *Mental Health and Physical Activity*, *4*(2), 79-87. https://doi.org/10.1016/j.mhpa.2011.08.002

Alam-Mehrjerdi, Z., Abdollahi, M., Higgs, P., & Dolan, K. (2015). Drug use treatment and harm reduction programs in Iran: A unique model of health in the most populated Persian Gulf country. *Asian Journal of Psychiatry*, *16*, 78-83.

Alves, D. (2011). Housing and employment situation, body mass index and dietary habits of heroin addicts in methadone maintenance treatment. *Heroin Addiction and Related Clinical Problems*, *13*(1), 11-14.

Barker, S. B., Kerns, L. L., & Schnoll, S. H. (1993). Assessment of medical history, health status, intoxication, and withdrawal. In B. J. Rounsaville (Ed.), *Diagnostic Source Book on Drug Abuse Research and Treatment* (pp. 35-48). U.S. Department of Health and Human Services.

Bommer, W. H., Rich, G. A., & Rubin, R. S. (2005). Changing attitudes about change: Longitudinal effects of transformational leader behavior on employee cynicism about organizational change. *Journal of Organizational Behavior: The International Journal of Industrial, Occupational and Organizational Psychology and Behavior*, *26*(7), 733-753.

Brigham, G. S., Feaster, D. J., Wakim, P. G., & Dempsey, C. L. (2009). Choosing a control group in effectiveness trials of behavioral drug abuse treatments. *Journal of Substance Abuse Treatment*, *37*(4), 388-397.

Cleary, M., Hunt, G. E., Matheson, S., & Walter, G. (2009). Psychosocial treatments for people with co-occurring severe mental illness and substance misuse: Systematic review. *Journal of Advanced Nursing*, *65*(2), 238-258.

Comiskey, C., Kelly, P., Leckey, Y., McCullough, L., O'duill, B., Stapleton, R., & White, E. (2009). *The ROSIE study: Drug treatment outcomes in Ireland*. Stationery Office.

Compton, W. M., Stein, J. B., Robertson, E. B., Pintello, D., Pringle, B., & Volkow, N. D. (2005). Charting a course for health services research at the National Institute on Drug Abuse. *Journal of Substance Abuse Treatment*, *29*(3), 167-172.

Copeland, J., & Martin, G. (2004). Web-based interventions for substance use disorders: A qualitative review. *Journal of Substance Abuse Treatment*, *26*(2), 109-116. https://doi.org/10.1016/s0740-5472(03)00165-x

Cowan, J., & Devine, C. (2008). Food, eating, and weight concerns of men in recovery from substance addiction. *Appetite*, *50*(1), 33-42. https://doi.org/10.1016/j.appet.2007.05.006

Daley, D. C. (2013). Family and social aspects of substance use disorders and treatment. *Journal of Food and Drug Analysis*, *21*(4), S73-S76.

Davis, D. A., Thomson, M. A., Oxman, A. D., & Haynes, R. B. (1995). Changing physician performance: A systematic review of the effect of continuing medical education strategies. *The Journal of the American Medical Association*, *274*(9), 700-705.

de Andrade, D., Elphinston, R. A., Quinn, C., Allan, J., & Hides, L. (2019). The effectiveness of residential treatment services for individuals with substance use disorders: A systematic review. *Drug and Alcohol Dependence*, *201*, 227-235.

De Leon, J., & Diaz, F. J. (2005). A meta-analysis of worldwide studies demonstrates an association between schizophrenia and tobacco smoking behaviors. *Schizophrenia Research*, *76*(2-3), 135-157.

Deenik, J., Czosnek, L., Teasdale, S. B., Stubbs, B., Firth, J., Schuch, F. B., . . . Lederman, O. (2020). From impact factors to real impact: Translating evidence on lifestyle interventions into routine mental health care. *Translational Behavioral Medicine*, *10*(4), 1070-1073.

Drake, R. E., O'Neal, E. L., & Wallach, M. A. (2008). A systematic review of psychosocial research on psychosocial interventions for people with co-occurring severe mental and substance use disorders. *Journal of Substance Abuse Treatment*, *34*(1), 123-138.

Dwayne Simpson, D. (2009). Organizational readiness for stage-based dynamics of innovation implementation. *Research on Social Work Practice*, *19*(5), 541-551.

Finnell, D. S. (2000). The case for teaching patients about the neurobiological basis of addictions. *Journal of Addictions Nursing*, *12*(3-4), 149-158.

Forman, R. F., Bovasso, G., & Woody, G. (2001). Staff beliefs about addiction treatment. *Journal of Substance Abuse Treatment*, *21*(1), 1-9.

Gorski, T. T. (1990). The Cenaps model of relapse prevention: Basic principles and procedures. *Journal of Psychoactive Drugs*, *22*(2), 125-133.

Hanson, G. R., Leshner, A. I., & Tai, B. (2002). Putting drug abuse research to use in real-life settings. *Journal of Substance Abuse Treatment*, *23*(2), 69-70.

Happell, B., Davies, C., & Scott, D. (2012). Health behaviour interventions to improve physical health in individuals diagnosed with a mental illness: A systematic review. *International Journal of Mental Health Nursing*, *21*(3), 236-247.

Institute of Medicine. (1998). *Bridging the Gap Between Practice and Research: Forging Partnerships with Community-Based Drug and Alcohol Treatment*. The National Academies Press. https://doi.org/doi:10.17226/6169

Jeffery, R. W., & Utter, J. (2003). The changing environment and population obesity in the United States. *Obesity Research*, *11 Suppl*, 12s-22s. https://doi.org/10.1038/oby.2003.221

Joe, G. W., Lehman, W. E., Rowan, G. A., Knight, K., & Flynn, P. M. (2019). The role of physical and psychological health problems in the drug use treatment process. *Journal of Substance Abuse Treatment*, *102*, 23-32.

Juel, A., Kristiansen, C. B., Madsen, N. J., Munk-Jørgensen, P., & Hjorth, P. (2017). Interventions to improve lifestyle and quality-of-life in patients with concurrent mental illness and substance use. *Nordic journal of psychiatry*, *71*(3), 197-204.

Karajibani, M., Montazerifar, F., Dashipour, A., Lashkaripour, K., Abery, M., & Salari, S. (2014). Effectiveness of educational programs on nutritional behavior in addicts referring to Baharan Hospital, Zahedan (Eastern of IR Iran). *International Journal of High Risk Behaviors and Addiction*, *3*(2), e18932. https://doi.org/10.5812/ijhrba.18932

Karam, E. G., Ghandour, L. A., Maalouf, W. E., Yamout, K., & Salamoun, M. M. (2010). A rapid situation assessment (RSA) study of alcohol and drug use in Lebanon. *Journal Medical Libanais*, *58*(2), 76-85.

Karam, E. G., Maalouf, W. E., & Ghandour, L. A. (2004). Alcohol use among university students in Lebanon: prevalence, trends and covariates. The IDRAC University Substance Use Monitoring Study (1991 and 1999). *Drug Alcohol Dependence*, *76*(3), 273-286. https://doi.org/10.1016/j.drugalcdep.2004.06.003

Kelly, P. J., Baker, A. L., Deane, F. P., Callister, R., Collins, C. E., Oldmeadow, C., . . . Keane, C. A. (2015). Study protocol: A stepped wedge cluster randomised controlled trial of a healthy lifestyle intervention for people attending residential substance abuse treatment. *BMC Public Health*, *15*(1), 465. https://doi.org/10.1186/s12889-015-1729-y

Kelly, P. J., Baker, A. L., Deane, F. P., Callister, R., Collins, C. E., Oldmeadow, C., . . . Keane, C. A. (2021). Healthy recovery: A stepped wedge cluster randomised controlled trial of a healthy lifestyle intervention for people attending residential alcohol and other drug treatment. *Drug and Alcohol Dependence*, *221*, 108557.

Khalsa, J. H., Treisman, G., McCance-Katz, E., & Tedaldi, E. (2008). Medical consequences of drug abuse and co-occurring infections: research at the National Institute on Drug Abuse. *Substance Abuse*, *29*(3), 5-16.

Kourounis, G., Richards, B. D. W., Kyprianou, E., Symeonidou, E., Malliori, M.-M., & Samartzis, L. (2016). Opioid substitution therapy: Lowering the treatment thresholds. *Drug and Alcohol Dependence*, *161*, 1-8.

Kremer, D., Malkin, M. J., & Benshoff, J. J. (1995). Physical activity programs offered in substance abuse treatment facilities. *Journal of Substance Abuse Treatment*, *12*(5), 327-333.

Lewer, D., Jones, N. R., Hickman, M., Nielsen, S., & Degenhardt, L. (2020). Life expectancy of people who are dependent on opioids: A cohort study in New South Wales, Australia. *Journal of Psychiatric Research*, *130*, 435-440.

Lewer, D., Tweed, E. J., Aldridge, R. W., & Morley, K. I. (2019). Causes of hospital admission and mortality among 6683 people who use heroin: A cohort study comparing relative and absolute risks. *Drug and Alcohol Dependence*, *204*, 107525.

Maremmani, I., Pani, P. P., Pacini, M., & Perugi, G. (2007). Substance use and quality of life over 12 months among buprenorphine maintenance-treated and methadone maintenance-treated heroin-addicted patients. *Journal of Substance Abuse Treatment*, *33*(1), 91-98.

Matthews, E., Van Hout, M. C., Scheibein, F., & Cowman, M. (2021). A qualitative study of physical activity and dietary practices of people accessing opioid agonist treatment in Ireland. *Heroin Addiction And Related Clinical Problems*, *23*, 1-10.

McGovern, M. P., Fox, T. S., Xie, H., & Drake, R. E. (2004). A survey of clinical practices and readiness to adopt evidence-based practices: Dissemination research in an addiction treatment system. *Journal of Substance Abuse Treatment*, *26*(4), 305-312.

McLellan, A. T., Woody, G. E., Metzger, D., McKay, J., Durell, J., Alterman, A. I., & O'Brien, C. P. (1996). Evaluating the effectiveness of addiction treatments: Reasonable expectations, appropriate comparisons. *The Milbank Quarterly*, 51-85.

MENHARA. (2021). *Assessment of situation and response of drug use and its harms in the Middle East and North Africa*. MENHARA.

Miller, W. R., Sorensen, J. L., Selzer, J. A., & Brigham, G. S. (2006). Disseminating evidence-based practices in substance abuse treatment: A review with suggestions. *Journal of Substance Abuse Treatment*, *31*(1), 25-39. https://doi.org/10.1016/j.jsat.2006.03.005

Newman, C. F. (1997). Establishing and maintaining a therapeutic alliance with substance abuse patients: A cognitive therapy approach. *NIDA Research Monograph*, *165*, 181-206.

Nielsen, B., & Houborg, E. (2015). Addiction, drugs, and experimentation: Methadone maintenance treatment between "In Here" and "Out There". *Contemporary Drug Problems*, *42*(4), 274-288.

Pathare, S., Brazinova, A., & Levav, I. (2018). Care gap: A comprehensive measure to quantify unmet needs in mental health. *Epidemiology and Psychiatric Sciences*, *27*(5), 463-467.

Peles, E., Schreiber, S., Sason, A., & Adelson, M. (2016). Risk factors for weight gain during methadone maintenance treatment. *Substance Abuse*, *37*(4), 613-618. https://doi.org/10.1080/08897077.2016.1179705

Prendergast, M. L., Urada, D., & Podus, D. (2001). Meta-analysis of HIV risk-reduction interventions within drug abuse treatment programs. *Journal of Consulting and Clinical Psychology*, *69*(3), 389-405.

Rawson, R. A., Marinelli-Casey, P., & Ling, W. (2002). Dancing with strangers: Will US substance abuse practice and research organizations build mutually productive relationships? *Addictive Behaviors*, *27*(6), 941-949.

Rehm, J., & Probst, C. (2018). Decreases of life expectancy despite decreases in non-communicable disease mortality: The role of substance use and socioeconomic status. *European Addiction Research*, *24*(2), 53-59.

Saloner, B., McGinty, E. E., Beletsky, L., Bluthenthal, R., Beyrer, C., Botticelli, M., & Sherman, S. G. (2018). A public health strategy for the opioid crisis. *Public Health Reports*, *133*(1_suppl), 24S-34S.

Simpson, D. D., Joe, G. W., Broome, K. M., Hiller, M. L., Knight, K., & Rowan-Szal, G. A. (1997). Program diversity and treatment retention rates in the Drug Abuse Treatment Outcome Study (DATOS). *Psychology of Addictive Behaviors*, *11*(4), 279-293.

Stewart, R. (2015). Mental disorders and mortality: so many publications, so little change. *Acta Psychiatrica Scandinavica*, *132*(5), 410-411.

Suetani, S., Rosenbaum, S., Scott, J., Curtis, J., & Ward, P. (2016). Bridging the gap: What have we done and what more can we do to reduce the burden of avoidable death in people with psychotic illness? *Epidemiology and Psychiatric Sciences*, *25*(3), 205-210.

Teasdale, S. B., Ward, P. B., Samaras, K., Firth, J., Stubbs, B., Tripodi, E., & Burrows, T. L. (2019). Dietary intake of people with severe mental illness: Systematic review and meta-analysis. *The British Journal of Psychiatry*, *214*(5), 251-259.

Thoits, P. A. (1986). Social support as coping assistance. *Journal of Consulting and Clinical Psychology*, *54*(4), 416-423.

Thompson, T. P., Horrell, J., Taylor, A. H., Wanner, A., Husk, K., Wei, Y., . . . Sinclair, J. (2020). Physical activity and the prevention, reduction, and treatment of alcohol and other drug use across the lifespan (The PHASE review): A systematic review. *Mental Health and Physical Activity*, *19*, 100360.

Uhl, A. (2007). How to camouflage ethical questions in addiction research. In J. Fountain & D. Korf (Eds.), *Drugs in Society. European Perspectives*. CRC Press.

Walker, E. R., Cummings, J. R., Hockenberry, J. M., & Druss, B. G. (2015). Insurance status, use of mental health services, and unmet need for mental health care in the United States. *Psychiatric Services*, *66*(6), 578-584.

Wiss, D. A., Russell, L., & Prelip, M. (2021). Staff-perceived barriers to nutrition intervention in substance use disorder treatment. *Public Health Nutrition*, *24*(11), 3488-3497.

Wiss, D. A., Schellenberger, M., & Prelip, M. L. (2019). Rapid assessment of nutrition services in Los Angeles substance use disorder treatment centers. *Journal of Community Health*, *44*(1), 88-94.

Zirakzadeh, A., Shuman, C., Stauter, E., Hays, J. T., & Ebbert, J. O. (2013). Cigarette smoking in methadone maintained patients: An up-to-date review. *Current Drug Abuse Reviews*, *6*(1), 77-84.

LIST OF PUBLICATIONS OF THE THESIS

Mahboub, N., Rizk, R., Karavetian, M., & De Vries, N. (2020). Nutritional status and eating habits of people who use drugs and/or are undergoing treatment for recovery: A narrative review. *Nutrition Reviews*, 79(6), 627-635.

Mahboub, N., Honein-Abou Haidar, G., Rizk, R., & de Vries, N. (2021). People who use drugs in rehabilitation, from chaos to discipline: Advantages and pitfalls: A qualitative study. *PLOS ONE*, 16(2), 1-17.

Mahboub, N., Rizk, R., & de Vries, N. (2021). Nutritional parameters and lifestyle practices of people who use drugs undergoing treatment for recovery in Lebanon: A descriptive study. *Journal of Nutritional Science,* 2021, 10(e16), 1-12.

Mahboub, N., Rizk, R., Farsoun, C, & de Vries, N. (under review). Patterns and determinants of weight gain among people who use drugs undergoing treatment for recovery in Lebanon.

Impact

This thesis explored the dietary and lifestyle parameters of an understudied population group in Lebanon: PWUD in treatment for recovery. Our results show that this population is susceptible to weight gain associated with the number of previous treatment attempts, duration of treatment, and pre-treatment BMI; in addition to food addiction, poor nutrition knowledge, physical inactivity, and poor sleep. Moreover, our findings highlight significant differences in the nutrition and lifestyle parameters between the two treatment modalities, i.e., rehabilitation and OST. Hence, our findings provide a baseline assessment of the nutrition and lifestyle habits of Lebanese PWUD undergoing treatment, and identify them as a group that is at risk of developing future chronic diseases should they continue to follow unhealthy lifestyle habits.

Given this, this thesis has several implications for research and practice.
Regarding scholars and scientists in Lebanon and abroad, we inform several directions for future research in the field of SUD. More research and funding should be invested in this population group as they exhibited unhealthy lifestyle behaviors posing them at high risk of future health problems adding to the burden of the health care system. Additionally, qualitative and quantitative studies should be carried out to gain more understanding of the different determinants of weight gain, poor sleep, low physical activity, and food addiction in each treatment modality separately, as patients exhibited different characteristics. Furthermore, longitudinal studies examining the implications of the weight gain as a long-term risk for chronic disease development and increasing risk of relapse are warranted. Moreover, the findings of these proposed studies can aid in designing evidence-based targeted health promotion programs to reduce risk of non-communicable disease. Finally, measuring the effectiveness of such programs in improving lifestyle and nutrition parameters on the long term is essential to determine the impact of the program in improving the health of PWUD in treatment specifically and public health in general.

In practice, we suggest targeting PWUD undergoing treatment for recovery with an appropriate primary intervention program. Such a program should focus on monitoring of weight gain, remediating food addiction, increasing nutrition knowledge, enhancing physical activity, and improving sleep. Moreover, this intervention program should also address smoking and alcohol abuse with the above-mentioned lifestyle parameters due to their detrimental effect on health (Glass et al., 2015; McKelvey et al., 2017), and improved substance use treatment outcomes when

treated (Myers et al., 2007). First, program administrators, health care providers, and patients and their families should be aware that these unhealthy lifestyle parameters increase the risk of chronic diseases. The results of this thesis should be disseminated among these parties to increase awareness about these issues. Second, these findings should also be propagated to the Ministries of Public Health and Social Affairs. The NGOs in Lebanon play an important role in combatting drug use and providing SUD treatment and prevention programs with limited resources available. Health promotion programs tackling unhealthy behaviors, proposed by this thesis, are lacking and are not a priority in treatment centers. Implementation of a health promotion program and providing primary health care initiatives and screening to PWUD in treatment have to be supported by national policies with a governmental key role. Third, we suggest using IM as a framework for the health promotion program as it is applied to guide behavior change interventions and health education development. This evidence-based approach, presented as a series of 6 steps in which we will elaborate further in this section, is a process that bridges the gap between theory and practice. With this in mind, IM ensures that the evidence-based health promotion program can be implemented in real-world settings.

Fortunately, PWUD in treatment centers are in a transition phase from a chaotic life to a disciplined one where they are gaining more autonomy over their choices in life, thus have a potential for positive behavior change enabling healthy habits (Cogswell & Negley, 2011; Zeldman et al., 2004). This stands true especially for people who voluntarily admitted themselves to treatment as this is a first step in making healthy choices opening a window for other lifestyle modifications. They are also at a stage in their life where their health behaviors can still impact their future health; therefore, supporting healthy habits through lifestyle interventions and health promotion programs at such a critical time, could be key to building a healthier population (Davies et al., 2015). Treatment rehabilitation centers are ideal institutions for such intervention programs since they provide the first steps towards lifestyle changes in all aspects under controlled professional support (Kelly et al., 2015). Moreover, they can be used as centers of research to develop, apply, and assess the effectiveness of evidence-based health promotion programs (Damschroder & Hagedorn, 2011). As for OST centers, implementation of such programs faces more challenges due to external factors in the patients' lives that are beyond the control of the health care providers. Auspiciously, we have found in the literature few examples where introduction of such programs have been

successful, particularly those that empower individuals by education and provide support for health improvement. (National Institutes of Health, 1999).

We suggest that the development of this health promotion program be based on the IM approach. IM follows the development of an intervention, mapping the path from recognition of a problem to the identification of a solution (Eldredge et al., 2016), and describes a protocol for the development of a theory and evidence-based intervention in six steps: 1) Needs assessment, 2) Identification of intervention objectives, 3) Selection of behavioral change models, 4) Designing an intervention program and piloting, 5) Implementation of the intervention program, and 6) Evaluation. This thesis informs the needs assessment (Step 1), defines intervention objectives (Step 2) which are necessary to implement an evidence-based intervention, and provides suggestions for future program evaluation (step 6).

Step 1: Needs assessment

Our results feed into the first step of the IM protocol: the needs assessment, in terms of: 1) assessing the nutritional status and dietary intake, nutrition knowledge, food addiction, and biochemical profiles, as well as sleep and physical activity of PWUD undergoing treatment for recovery in Lebanon, 2) exploring the major significant differences in these parameters between the offered treatment modalities, namely OST and rehabilitation, 3) examining the patterns and extent of weight change and explore the differences in these variables between people receiving OST and those undergoing rehabilitation, and 4) exploring the determinants of weight gain in this population group. Moreover, the needs assessment involved literature search and explored qualitatively these dietary and lifestyle practices of PWUD undergoing treatment in Lebanon and perceived benefits and pitfalls. This provided information on the issue barriers, facilitators, and recommendations for the development of an intervention program. The program goals and objectives were identified at the completion of the needs assessment.

Step 2: Intervention objectives

We identified the following objectives which should be addressed through future interventions:

- Raise awareness among treatment program administrators, health care providers, and patients and their families about the increased weight gain, inappropriate food intake, food addiction, poor nutrition knowledge, poor sleep, low physical activity of PWUD in treatment centers.
- Raise awareness about the impact of these disturbed lifestyle parameters on the development of future health diseases and risk of relapse and provide methods of screening.
- Promote healthy eating behaviors among PWUD in treatment by designing and providing daily healthy menus in treatment centers.
- Provide general nutrition education to all patients undergoing treatment in addition to individualized nutrition consultations by a dietitian to those in need.
- Provide a variety of individualized physical activity programs in treatment centers tailored to needs and tolerance of the participants.

Step 6: Evaluation

Suggestions for future evaluation of the outcomes achieved from the health promotion program:

- Monitoring weight change and anthropometric measurements across different intervals of the treatment by the health care providers.
- Longitudinal evaluation of biochemical parameters.
- Measuring physical activity participation among the participants.
- Monitoring sleep levels among the participants.
- Assessing the perceptions of the participants on the knowledge gained and changes implemented from the intervention, in addition to its usefulness and application with additional recommended changes by conducting focus group and in-depth interviews.

In the future, a thorough literature review should be conducted to choose the most appropriate behavioral change models (step 3), create program content and pilot it (step 4), implement it (step 5), and evaluate it to ensure its efficacy (step 6).

References

Cogswell, J., & Negley, S. K. (2011). The effect of autonomy-supportive therapeutic recreation programming on integrated motivation for treatment among persons who abuse substances. *Therapeutic Recreation Journal*, *45*(1), 47-61.

Damschroder, L. J., & Hagedorn, H. J. (2011). A guiding framework and approach for implementation research in substance use disorders treatment. *Psychology of Addictive Behaviors*, *25*(2), 194-205.

Davies, G., Elison, S., Ward, J., & Laudet, A. (2015). The role of lifestyle in perpetuating substance use disorder: The lifestyle balance model. *Substance Abuse Treatment, Prevention, and Policy*, *10*(1), 1-8.

Eldredge, L. K. B., Markham, C. M., Ruiter, R. A., Fernández, M. E., Kok, G., & Parcel, G. S. (2016). *Planning health promotion programs: An intervention mapping approach*. John Wiley & Sons.

Glass, J. E., Hamilton, A. M., Powell, B. J., Perron, B. E., Brown, R. T., & Ilgen, M. A. (2015). Specialty substance use disorder services following brief alcohol intervention: a meta-analysis of randomized controlled trials. *Addiction*, *110*(9), 1404-1415.

Kelly, P. J., Baker, A. L., Deane, F. P., Callister, R., Collins, C. E., Oldmeadow, C., . . . Keane, C. A. (2015). Study protocol: A stepped wedge cluster randomised controlled trial of a healthy lifestyle intervention for people attending residential substance abuse treatment. *BMC Public Health*, *15*(1), 465. https://doi.org/10.1186/s12889-015-1729-y

McKelvey, K., Thrul, J., & Ramo, D. (2017). Impact of quitting smoking and smoking cessation treatment on substance use outcomes: An updated and narrative review. *Addictive Behaviors*, *65*, 161-170.

Myers, M. G., Doran, N. M., & Brown, S. A. (2007). Is cigarette smoking related to alcohol use during the 8 years following treatment for adolescent alcohol and other drug abuse? *Alcohol and Alcoholism*, *42*(3), 226-233.

National Institutes of Health. (1999). *Epidemiologic Trends in Drug Abuse*. National Institutes of Health.

Zeldman, A., Ryan, R. M., & Fiscella, K. (2004). Motivation, autonomy support, and entity beliefs: Their role in methadone maintenance treatment. *Journal of Social and Clinical Psychology*, *23*(5), 675-696.

Summary

Substance use disorder (SUD) is a major public health problem that has a detrimental impact on health, substantially contributing to the global burden of communicable and non-communicable diseases. Effective treatments for SUD are essential to reduce the impact of substance use on both the individual and society. There are two main types of treatments used for SUD: detoxification (complete abstinence) or the opioid substitution treatment (OST). Once referred to treatment, a major shift occurs in the lifestyle of people who use drugs (PWUD) especially concerning nutrition and metabolism. Addressing the lifestyle practices and improving the quality of life of PWUD seems to decrease the risk of relapse. Studies emphasizing proper nutrition, physical activity, and adequate sleep potentially associated with better physical and mental wellbeing in SUD, are scarce. Lebanon, is a small high-middle income country in the Eastern Mediterranean region that showed a rapid progression of substance use disorder from the onset of civil war. Research on SUD in Lebanon is scarce and when present, it either focuses on the prevalence of a specific drug in a specific segment of the population, or on the prevalence of infectious diseases among people who inject drugs (PWID) for harm reduction policy adoption. Studies focusing on the nutritional status, dietary and lifestyle practices of people who actively use drugs (PWUD) and those who are undergoing treatment for recovery are non-existing.

The study assessed the nutritional status and lifestyle practices among PWUD undergoing treatment for recovery in Lebanon. Furthermore, we explored significant differences in these parameters depending on the offered treatment modality, namely OST and rehabilitation. Finally, we examined the patterns and extent of weight change, and explored the determinants of weight gain among this population group.

In Chapter 2, we reviewed the evidence addressing the nutritional status and dietary habits of people actively using drugs and those in treatment. Substantial evidence supported decreased food intake, irregular eating patterns, and increased preference for sweet taste among PWUD. Moreover, this population group exhibited hidden deficiencies and disturbed metabolic parameters. Regarding users undergoing treatment, scarce available data indicated improvement in anthropometric and metabolic parameters, but with micronutrient intake remaining suboptimal. Weight gain was noted especially among females, potentially increasing the risk of relapse.

In Chapter 3, we pioneered in qualitatively exploring the dietary intake, sleep, and physical activity of PWUD undergoing treatment in rehabilitation centers in Lebanon. We found that rehabilitation centers enforced a disciplined routine lifestyle practice in terms of nutrition, sleep, and physical

activity that was appreciated by most participants. Yet, this strict regimen was viewed as suboptimal as it should address individuals' preferences and needs in terms of binge eating, lack of sleep, and type and frequency of physical activity offered. Furthermore, follow-up treatment in the community, at the end of the rehabilitation period, was also expressed as a need among most of the participants.

Also, nutritional parameters and lifestyle practices of PWUD were quantitatively assessed. The nutritional status, anthropometric measures, dietary intake, nutrition knowledge, food addiction, and biochemical profiles, as well as sleep and physical activity of PWUD in both OST and rehabilitation centers were measured (chapter 4). Furthermore, we explored major differences in these parameters between the two offered treatment modalities. Our results showed that PWUD undergoing treatment for recovery were subject to excessive weight gain that was significantly higher among those undergoing rehabilitation. Poor sleep quality was also significantly higher in the rehabilitation group, whereas physical activity was lower among PWUD in the OST centers. Finally, poor nutrition knowledge and high food addiction level were seen in both treatments with no significant difference between them.

Finally, in Chapter 5 we examined the patterns and extent of weight change and explored the determinants of weight gain in our sample. Our results showed that the majority of the participants who were initially in the underweight, normal, and overweight categories mainly gained weight during treatment and moved to a higher BMI category in both treatment modalities. This shift in the BMI was significantly higher in the rehabilitation group. On the other hand, the majority of the participants who were initially obese maintained their status. We also found that the number of previous treatment attempts and duration of treatment were negatively associated with weight gain. PWUD undergoing treatment for recovery in Lebanon are subject to various vulnerability factors creating challenges to treatment. Furthermore, SUD treatment is associated with meaningful weight gain and unhealthy lifestyle parameters that might lead to health risk factors. These findings shed the light on the importance of addressing these parameters to improve the overall rehabilitation experience, prevent relapse, and inform the development of future targeted health promotion intervention programs tackling aspects of behavioral changes in nutrition, sleep, and physical activity.

Integrated lifestyle interventions are increasingly being recognized as important components of routine care of PWUDs undergoing treatment for recovery. Yet, the feasible and sustainable

implementation of these interventions in routine care is challenging, as it requires a deeper understanding of the patients' needs, in addition to identifying facilitators and barriers experienced by both users and health providers.

The findings of this study fill an important gap in this regard by providing the foundation of a framework for a health intervention program targeting nutrition and lifestyle practices of PWUD in treatment in Lebanon. Yet, it is important to acknowledge that there are several limitations hindering the generalizability of the results including the low representation of females, not addressing other lifestyle factors like alcohol and smoking which might have an effect on the weight gain observed, and the social and economic hardships that Lebanon is facing, which pose further challenges to the participants affecting their nutrition and lifestyle factors.

WORDS OF THANKS

To my great promoter, Dr. Nanne de Vries. Thank you for making my PhD experience a positive one, with your continuous support, motivation, and encouragement. Your immense knowledge and wisdom have guided me through every step of my work and helped me grow and enhance my skills as a researcher. Your generosity has no boundaries; for this I will always be grateful to you.
To Dr. Rana Rizk, my dear friend and mentor. I am extremely lucky to have you as my supervisor. Thank you so much for your constant availability, continuous support, and encouragement. Your calmness, confidence, and reassurance steered me in times of panic. You helped me cope with difficult situations and guided me through my work every step of the way. You were always accommodating when I had family obligations that interrupted my work flow. In short, I would not have been able to get through it all without you there.
To my dear and supportive husband Nahed, thank you for always standing by me, encouraging me, and helping me make this dream come true. I am forever appreciative that I have you as a partner.
My wonderful daughters, Tatiana and Naya. It is because of you that I have the desire to not only succeed but to excel. I know that at times I may have been distant because of my travels and work obligations, but you were always in my heart and will always be my number one in life.
To my mother Fariha, without whom nothing would have been possible, and I cannot thank you enough for your presence in my life and for taking care of my girls when I was away.
To my beloved sister Dania, thank you for your confidence in me.
Thank you, Maastricht University and CAPHRI for giving me the opportunity to enroll in the external PhD program. I feel a sense of belonging to your prestigious institution and your charming city.
I cannot express enough appreciation to the administration and the patients in all the drug treatment centers in Lebanon for allowing me to conduct the research on their premises.
Last but not least, I dedicate this thesis to the memory of my father Samih. I hope I made you proud.

Nadine

CURRICULUM VITAE

ABOUT THE AUTHOR

Nadine Mahboub obtained her bachelor of sciences in Nutrition and Food Technology and her master of sciences in Nutrition from the American University of Beirut, Lebanon. She is a licensed dietitian by the Ministry of Public Health in Lebanon and a state registered dietitian in the United Kingdom. Ms. Mahboub worked as head of dietary department in the Middle East hospital in Lebanon, and later as a therapeutic dietitian at the American University of Beirut Medical Center with focus on cardiac and respiratory disorders. Later, she moved to a career in academics where she has, since 2008, been an instructor and nutrition program coordinator at the Lebanese International University. Moreover, Ms. Mahboub was an international consultant by the World Health Organization (WHO) in the Ministry of Health in Kuwait.

Ms. Mahboub is a member of the Lebanese Academy of Nutrition and Dietetics (LAND), Hellenic Society for Clinical Nutrition & Metabolism (GrESPEN), and the European Society for Clinical Nutrition and Metabolism (ESPEN). She is also a certified instructor for Clinical Nutrition and Metabolism by ESPEN.

PEER-REVIEWED ARTICLES

Abboud, M., Al Anouti, F., Papandreou, D., Rizk, R., **Mahboub, N**., & Haidar, S. (2021). Vitamin D status and blood pressure in children and adolescents: a systematic review of observational studies. Systematic reviews, 10(1), 1-30.

Abboud, M., AlAnouti, F., Papandreou, D., Rizk, R., **Mahboub, N**., & Haidar, S. (2021). Vitamin D Status and Blood Pressure in Children and Adolescents: A Systematic Review of Observational Studies. *Nutrients,* 10:60:1-30.

Abboud, M., Rizk, R., AlAnouti, F., Papandreou, D., Haidar, S., & **Mahboub, N.** (2021). The Health Effects of Vitamin D and Probiotic Co-Supplementation: A Systematic Review of Randomized Controlled Trials. *Nutrients,* 13(111), 1-16.

Al Anouti, F., Abboud, M., Papandreou, D., Haidar, S. A., **Mahboub, N**., & Rizk, R. (2021). Oral Health of Children and Adolescents in the United Arab Emirates: A Systematic Review of the Past Decade. *Frontiers in Oral Health*. 2:744328. doi: 10.3389/froh.2021.744328

AlAnouti, F., Abboud, M., Papandreou, D., **Mahboub, N**., Haidar, S., & Rizk, R. (2020). Effects of Vitamin D Supplementation on Lipid Profile in Adults with the Metabolic Syndrome: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Nutrients,* 12(11), 3352, 1-25.

Mahboub, N., Honein-Abou Haidar, G., Rizk, R., & de Vries, N. (2021). People who use drugs in rehabilitation, from chaos to discipline: Advantages and pitfalls: A qualitative study. *PLOS ONE*, 16(2), 1-17.

Mahboub, N., Rizk, R., & de Vries, N. (2021). Nutritional parameters and lifestyle practices of people who use drugs undergoing treatment for recovery in Lebanon: A descriptive study. *Journal of Nutritional Science,* 2021, 10(e16), 1-12.

Mahboub, N., Rizk, R., Karavetian, M., & De Vries, N. (2020). Nutritional status and eating habits of people who use drugs and/or are undergoing treatment for recovery: A narrative review. *Nutrition Reviews*, 79(6), 627-635.